سركت

SERKET

The Arachnological Bulletin of the Middle East and North Africa

Volume 16 **Part 3**

December, 2018 **Cairo, Egypt**

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ISSN: 1110-502X

SERKET

Volume 16 Part 3

December, 2018 Cairo, Egypt

Contents

Volume 16 (2018-2019)
Back issues: Vol. 1 (1987-1990), Vol. 2 (1990-1992), Vol. 3 (1992-1993), Vol. 4 (1994-1996), Vol. 5 (1996-1997), Vol. 6 (1998-2000), Vol. 7 (2000-2001), Vol. 8 (2002-2003), Vol. 9 (2004-2005), Vol. 10 (2006-2007), Vol. 11 (2008-2009), Vol. 12 (2010-2011), Vol. 13 (2012-2013), Vol. 14 (2014-2015), Vol. 15 (2016-2017).
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ISSN: 1110-502X

Serket (2018) vol. 16(3): 105-132.

Spiders (Arachnida: Araneae) of Mayotte Island, Comoros Archipelago: bibliographical synthesis and new field observations

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Abstract

This paper focuses on the spider species (Arachnida: Araneae) that could be found on Mayotte Island, Comoros Archipelago. A bibliographical synthesis is presented and illustrated by recent pictures. Recent field observations of non-reported species are also included. More than 40 spider species are listed hereafter: new species have been added to the already known species reported within the scientific literature and probably more should be found and identified. It highlights the fact that participative sciences done by people sharing their findings could be complementary to accurate scientific studies as it allows to locate and eventually identifying new species in remote areas.

Keywords: Spiders, Araneae, Catalogue, Mayotte, Comoros.

General settings

Before dealing with spiders, it is worth recalling some important facts about Mayotte Island, in terms of geology, geography, and human activities.

Geology

Mayotte '*Maore*' is a small archipelago of 374 km² belonging to the Comoros Archipelago, *the islands of the Moon*. It is located in the northern part of the Mozambique Canal, western Indian Ocean, about 340 km west of the touristic island of Nosy Bé, Madagascar and 500 km to the east coast of Africa (Mozambique, Fig. 1a). There are three main inhabited islands, Grande-Terre (to the west), Petite-Terre (to the east),

Chissioua Mtsamboro (to the north), and a bunch of little islands like Mbouzi or Bandrélé islets (Fig. 1b). All these islands and islets owned to the same volcanic complex that began to build between 15 and 10 million years ago, with an emerged part circa 8-10 million years ago (Debeuf, 2009). The maximum elevation of these islands is reached by the Mount Bénara at 660 m. The red soil, or ferrous soil, found everywhere on the archipelago is coming from the erosion and alteration of volcanic rocks (Zinke *et al.*, 2003) sometimes to a depth of 30 m (Raunet, 1992). At the present time, Mayotte is surrounded by one of the largest lagoons in the world showing an overall surface of ~1500 km². Most of the island sheltered bays are bordered by mangrove forests, representing important buffer areas between the land and the lagoon. The coastal area is mixing with soil and coral debris coming mainly from the fringing reef that is, in some places, not really separated from the shoreline.

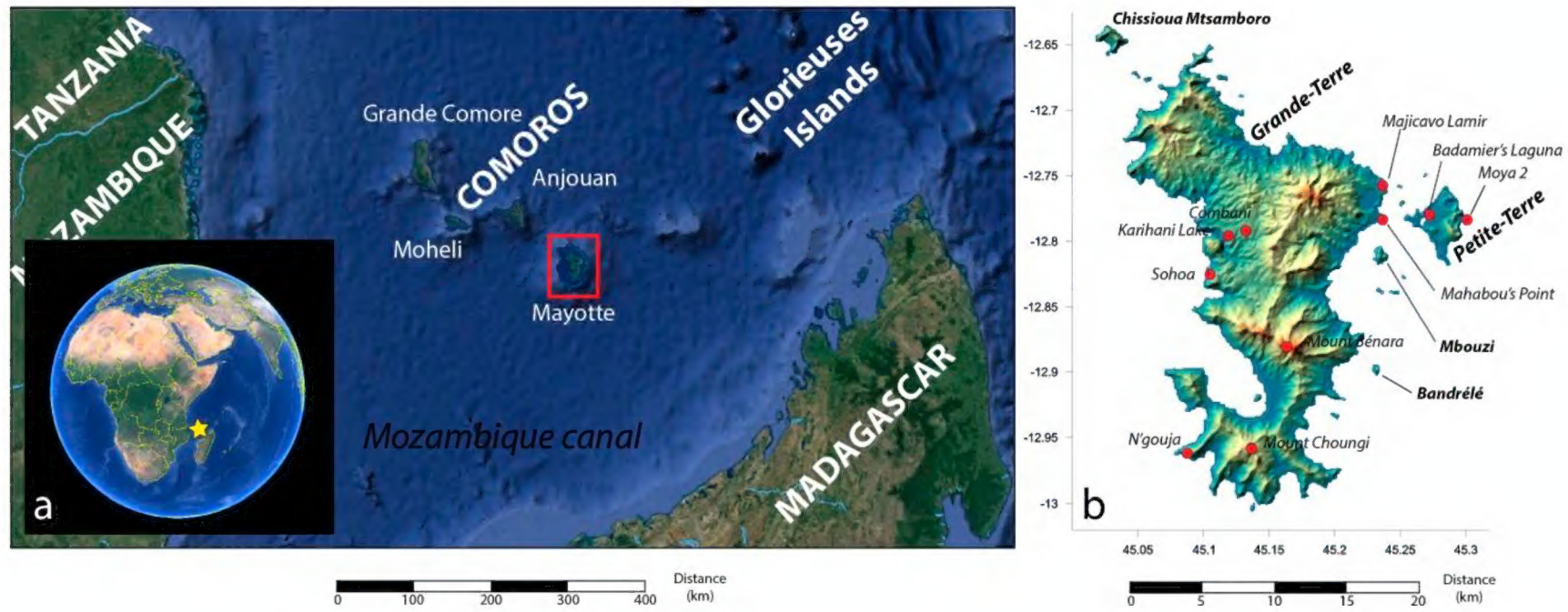

Fig. 1. Geographic settings: a. Location of the Comoros on Earth and Mayotte within the Comoros Archipelago (Source: Google Earth). b. Mayotte – the red dots locate some of the observation sites mentioned in the text (Source: SRTM data).

Climatology

The climate in the Comoros is moist tropical, showing low daily and annual temperature variations, dominated by the NE monsoon from November to March bringing rainfalls from 1500 to 2500 mm/year (Zinke *et al.*, 2003). Nevertheless, there are two well-differentiated seasons: a warm and rainy season from December to April and a dry and colder one from May to November (Raunet, 1992). The northern part of the island and more specifically the coastal zone from Longoni to Chiconi is more exposed to monsoon rainfalls while the south-east is drier. Over the past decades it is well known that Mayotte has been impacted by several strong tropical storms despite its relative protection behind Madagascar (Legoff, 2010).

Vegetation

To understand where the animal species found on Mayotte Island come from, one could have a look to the origin of plants. According to Pascal *et al.* (2001), Mayotte's vegetation is rich showing a large amount of families and species, but with a poor endemic rate. That way, several inventories have been led on Mayotte Island, allowing Pascal *et al.* (2001) to propose a plausible hypothesis regarding the origins of the flora: most of the species should have arrived from Madagascar at the end of the Tertiary, and it is only recently (~10000 years ago) that a new wave of immigration arrived from Africa and settled mainly onto coastal areas.

Anthropic pressures

Habitation evidences from the 6th century indicate that the early settlers of Mayotte were Bantu-speaking people from Africa. Mixed mainly with people from Madagascar and the Arabic Peninsula, Mayotte counted only several thousands of inhabitants when France bought it in 1841 from the Malagasy King Andriantsoly, Sultan of Mayotte. Since then, the population growth rate changed a bit probably due to the relative security brought by the French Administration over the Comoros, which were regularly the theatre of fratricidal wars. In 1974, when the Comorians were asked whether they wanted to become independent, Mayotte's population reached more than 45000. Forty three years after, in 2017, it reaches more than 256000 people, without taking into account the unauthorized migrants reaching between 40000 and 50000 people in 2018. This rising population needs more and more place and food and the poor people live in makeshift houses build sometimes in natural areas, cutting trees and clearing land using fire to crop bananas, manioc or corn. For instance, Barthelat & Viscardi (2012) underlined that 65% of Mayotte's surface is covered by forests in 1987, a ratio reduced to less than 20% today according to the National Observatory of Biodiversity (ONB). Thus, the total forest cover including mangroves has lost ~45% of its surface over the last 30 years, impacting considerably the fragile balance of the invaluable ecosystems and biodiversity. It is to notice that only 5% of the original forest remained in 2012. This frenetic deforestation leads to a dramatic erosion rate of the island soils leading to nearly "dead" areas called badlands or *padzas* (Izard *et al.*, 1999).

In addition to deforestation and erosion, pollution and pesticide application are of major concern in Mayotte. In a close future it will certainly lead to the extinction of numerous species, beginning with arthropods like insects or spiders.

Spiders

Spiders belong to Order Araneae. According to the World Spider Catalog (2018), there are currently more than 47000 recorded spider species and 4000 genera in the whole world and scientists estimate that there are still thousands of species to be discovered (up to 120000 according to Agnarsson *et al.* (2013). Within this incredible broad range of species, some of them are distributed worldwide, although others are found only in specific ecosystems (forests, peatlands, etc.), geographically restraint (remote islands, caves, desert, etc.) or dependant to some flora species like mosses (Glime, 2017). Order Araneae accounts for a major part of the biodiversity of specific hotspots.

A few decades ago, within the general framework of biodiversity loss around the World, Myers (1990) and Myers *et al.* (2000) defined the concept of 'biodiversity hotspots' as places where there are both a high level of endemism and an exceptional loss of natural habitats. According to Hanson *et al.* (2009), Mayotte is part of one of the 34 hot spots of biodiversity identified all around the planet (i.e. Madagascar and the Indian Ocean islands) and IUCN positioned it at the 26th rank of biodiversity losses by country. This has been estimated using data concerning flora because fauna and especially terrestrial fauna is not well-known in Mayotte, some species family never having been studied.

Thus, in Mayotte little is known about Class Arachnida, and more specifically Order Araneae. Only specific studies focusing on a handful of species have been published over the past century.

Objective of this paper

In this paper, an overview of the knowledge about spiders (Araneae) of Mayotte Island is presented, combined to the spiders observed and scientifically identified, including those found by the author who spent 11 months on the island from August 2017 to July 2018. As the objective was not to collect and identify meticulously all the spiders that could be found on Mayotte, this article aims to provide to the readers a new overview of the arachnids richness of this island. It also shows that only walking around could help to highlight new species in a low-studied place, like it has been done by Locket (1980) in Grande Comore.

Overview about Mayotte's spiders

The spiders of Mayotte Island, and only those that have been observed, are classified hereafter following the spider "tree of life" from Garrison *et al.* (2016) and Wheeler *et al.* (2016). This new classification is based on an accurate and systematic phylogenetic analysis of 115 spider families and 726 genera. Species names preceded by symbol * represent species first recorded from Mayotte.

Mygalomorphae

Family **Barychelidae** Simon, 1889
Genus ***Idioctis*** L. Koch, 1874
- *Idioctis intertidalis* (Benoit & Legendre, 1968): this mygalomorph, identified firstly from Madagascar, has been found as a permanent resident of the Badamiers Laguna on Petite-Terre Island, Mayotte Archipelago (Conservatoire du littoral, 2011). It is one of Mayotte iconic symbols of endangered and protected species. It lives within the intertidal zone, in a hole closed by a trapdoor, giving its common genus name: trapdoor spider. The individual shown on Fig. (2) is measured 13 mm and has been found in the Badamiers Laguna (12.783677°S, 45.262599°E) on 22.vi.2013 (Norbert Verneau, pers. comm., 2018).

Another mygalomorph, called *Moggridgea nesiota* Griswold, 1987, has been described from Moheli, Comoros, and only there. There is actually no report of such species from Mayotte.

Fig. 2. Mygalomorph *Idioctis intertidalis* from the Badamiers Laguna, Mayotte. a. frontal view. b. dorsal view (Courtesy of Norbert Verneau).

Lost Tracheae clade

Family **Pholcidae** C.L. Koch, 1850
Genus ***Spermophora*** Hentz, 1841
One new species has been found in Mayotte and described by Huber (2003):
- * *Spermophora jocquei* Huber, 2003

Araneoidea

Family **Theridiidae** Sundevall, 1833
Genus ***Anelosimus*** Simon, 1891

Agnarsson *et al.* (2010) found in Mayotte a species of Theridiidae already known from Madagascar:
- *Anelosimus decaryi* (Fage, 1930)

They also described a new species from Mayotte:
- * *Anelosimus amelie* Agnarsson, 2009

Fig. 3. *Latrodectus geometricus*. a. egg sacs under a table in Sada. b. female, dorsal view (Courtesy of Rémy Eudeline). c. female breeding (J. Roger).

Another species of Theridiidae not already recorded from Mayotte is presented below:
Genus ***Latrodectus*** Walckenaer, 1805

- *Latrodectus geometricus* C.L. Koch, 1841: the brown widow spider is only recorded from Grande Comore (Locket, 1980) for what concerns the Comoros Archipelago. Three occurrences are indicated here for Mayotte: two breeding individuals have been observed in Sada (45.105032°E, 12.850323°S) on 01.vii.2017 (Fig. 3a) and in Voundze Forest (45.161562°E, 12.873009°S) on 11.x.2017 (Fig. 3b) (Rémy Eudeline, pers. comm., 2018). Another individual (L~20mm) has been observed breeding at Coconi's agricultural school, in the park behind the renowned market (45.137140°E, 12.834221°S) on 13.x.2017 (Fig. 3c). Their general shape and patches on the abdomen leave no room for doubt.

Genus ***Argyrodes*** Simon, 1864
- * *Argyrodes chounguii* Lopez, 2010: recorded for the first time in Mayotte.
- *Argyrodes zonatus* (Walckenaer, 1841)
Several *Argyrodes* sp. have been observed in Mayotte (Fig. 4), but the identification post-observation based only on pictures did not allow identifying the species.
(*Note*: *Argyrodes minax* O. Pickard-Cambridge, 1880 has been collected in Madagascar and the Comoros).

Fig. 4. *Argyrodes* sp., ventral and lateral views, Majicavo Lamir, Mayotte (J. Roger).

Genus ***Ariamnes*** Thorell, 1869
- Several individuals of *Ariamnes* sp. have been observed by Rémy Eudeline (Pers. comm., 2018) on Mayotte Is. and are shown on Fig. (5). No species of *Ariamnes* are already known from the Comoros.

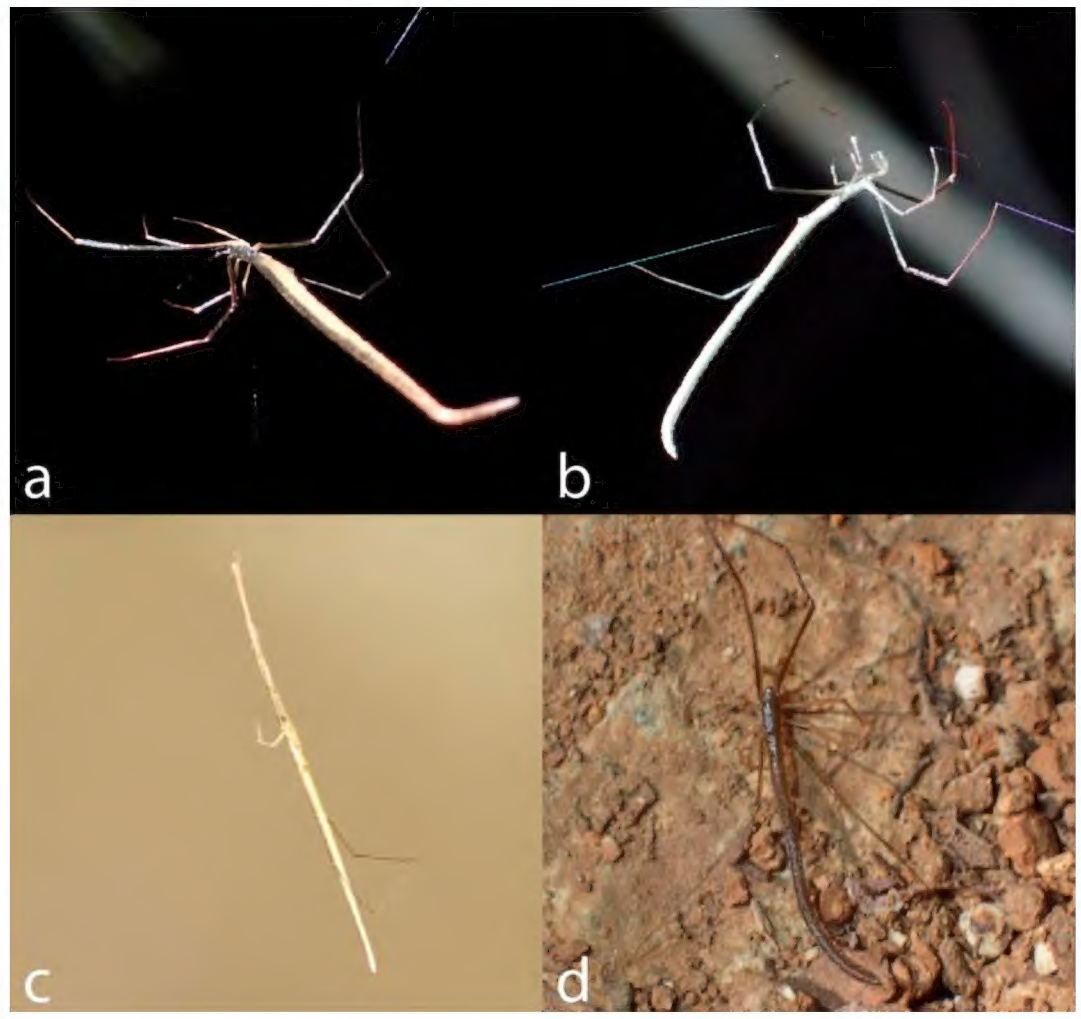

Fig. 5. *Ariamnes* sp. from Mayotte (Courtesy of Rémy Eudeline).

Genus ***Thwaitesia*** O. Pickard-Cambridge, 1881
- There are several *Thwaitesia* sp. reported from Madagascar, East Africa and even from La Réunion Is., but none from the Comoros. Fig. (6) shows two individuals of the same species observed on Mayotte by Rémy Eudeline (pers. comm., 2018).

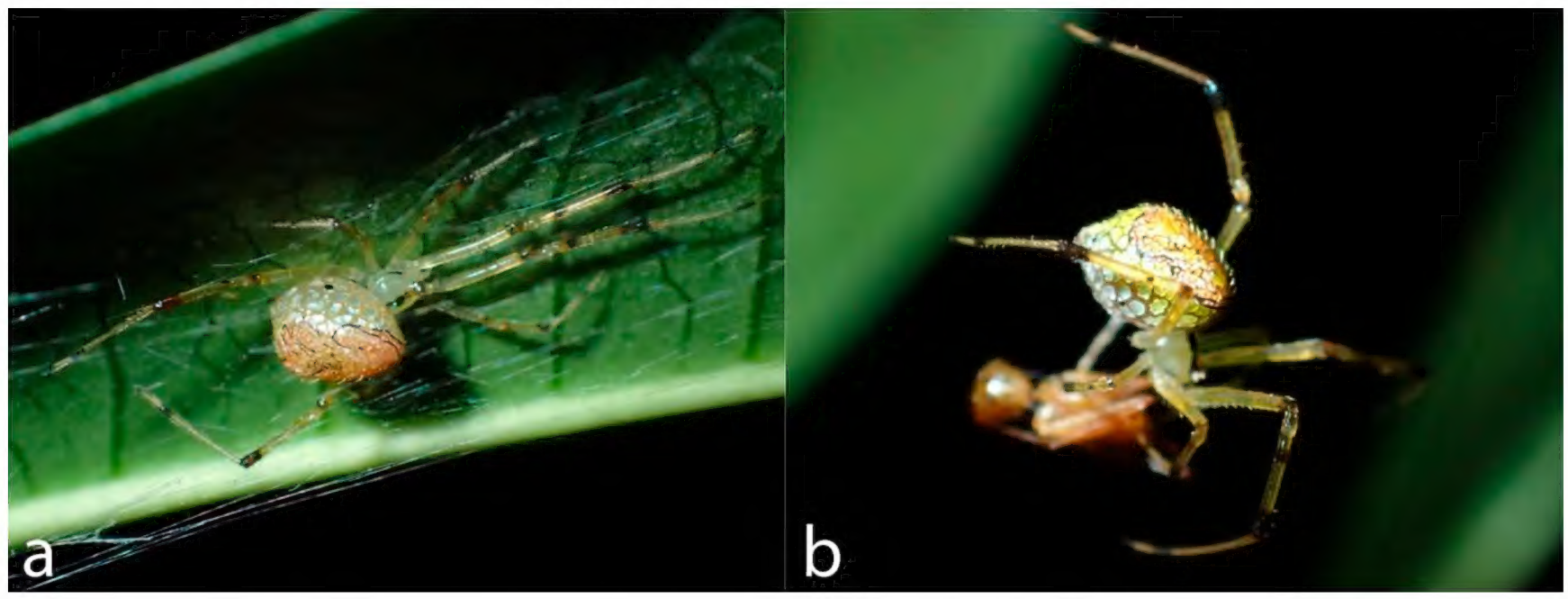

Fig. 6. *Thwaitesia* sp. from Mayotte (Courtesy of Rémy Eudeline).

Family **Araneidae** Clerck, 1757 – orb-weavers
Genus ***Arachnura*** Vinson, 1863
- *Arachnura scorpionoides* Vinson, 1863 has been reported on Mayotte Is. (on Mbouzi islet) by Bosca *et al.* (2013).

Genus ***Nephila*** Leach, 1815

When you ask locals about spiders, immediately they think about the impressive golden orb spider *Nephila*. This genus of spiders has been studied all around the Indian Ocean islands by Kuntner & Agnarsson (2011) who wanted to understand its

phylogeography. The authors indicated that three genera of nephilid spiders are found on Mayotte Island: *Nephila*, *Nephilingis*, and *Clitaetra*.

There are two spiders of genus *Nephila* reported on Mayotte:

- *Nephila inaurata madagascariensis* (Vinson, 1863), also known as the red-legged golden orb-weaver spider, is a big spider (the female body could reach 5 cm) found in Madagascar and Mayotte (Figs. 7a,b). *N inaurata* is a widely distributed spider in the Indian Ocean Islands (Réunion, Mauritius, Madagascar, Seychelles, etc.). It has been first described by Vinson (1863) who named it *Epeira madagascariensis*.

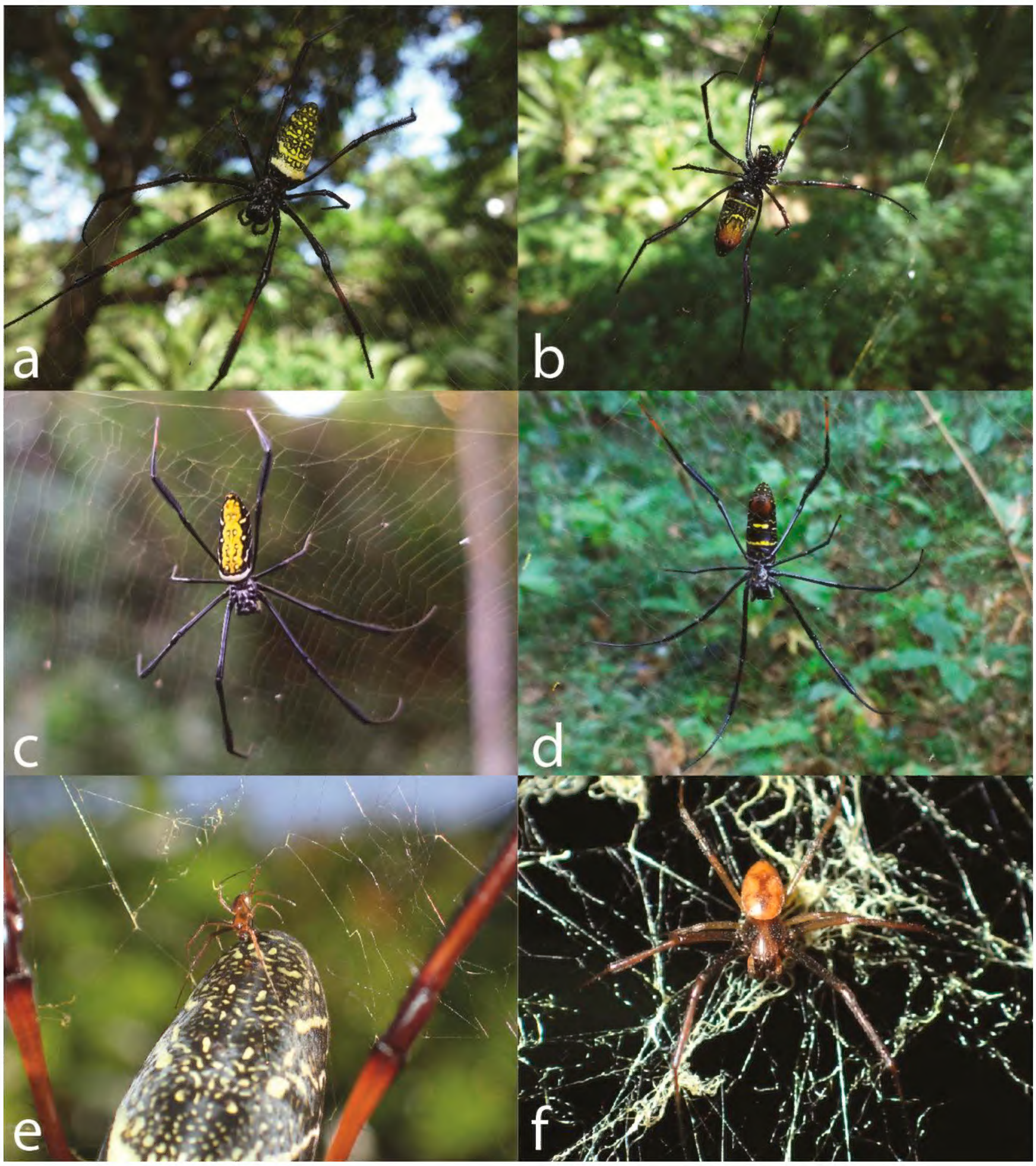

Fig. 7. *Nephila* sp. from Mayotte. a-b, e-f. *N. inaurata madagascariensis*. a. dorsal view. b. ventral view. e. sexual dimorphism. f. male (Courtesy of Rémy Eudeline). c-d. *N. comorana*. c. dorsal view. d. ventral view (J. Roger).

- *Nephila comorana* Strand, 1916: endemic of the Comoros (Figs. 7c,d); the yellow markings on the adult abdomen tend to merge (Lopez, 2010) and the legs are almost black. This species is protected under French legislation on endangered species.

Schmidt & Jocqué (1986) indicated that the female epigyne of *N. comorana* resembles more to the epigyne of *N. pilipes* (Fabricius, 1793) from Asia and Australia than that of *N. inaurata madagascariensis*. Both species show an important sexual dimorphism (Figs. 7e,f); the male measures only about 5 to 6 mm.

Genus ***Nephilingis*** Kuntner, 2013

- *Nephilingis livida* (Vinson, 1863)

The Madagascar hermit spider is common in Madagascar and nearby islands (Seychelles and Comoros Islands) according to Vinson (1863) and Kuntner *et al.* (2017). Vinson (1863) described it as a nocturnal spider, hiding during the daylight and hunting mainly night butterflies on its web during the night (at dusk) principally.

Several individuals have been encountered on Mayotte Is. by Lopez (2010). The author has found several other individuals especially within the Mount Bénara forest (Fig. 8). Testimonies have also been communicated (Rémy Eudeline, pers. comm., 2018).

As for *Nephila* sp., *Nephilingis livida* shows strong dimorphism between male and female (Fig. 8a). Its general appearance makes no doubt, with a shiny black to reddish cephalothorax, with rounded edges and a trough in the middle, showing prominent eyes on a round and domed head (Figs. 8b,c,d). The big ovoid rounded light to livid coloured abdomen overlays the cephalothorax partly due to its forward tilt. There are several black dots on the abdomen, four of them forming a quadrangle, and white rounded patches on the belly. Legs are strong, shiny black and the femora are sometimes red brown.

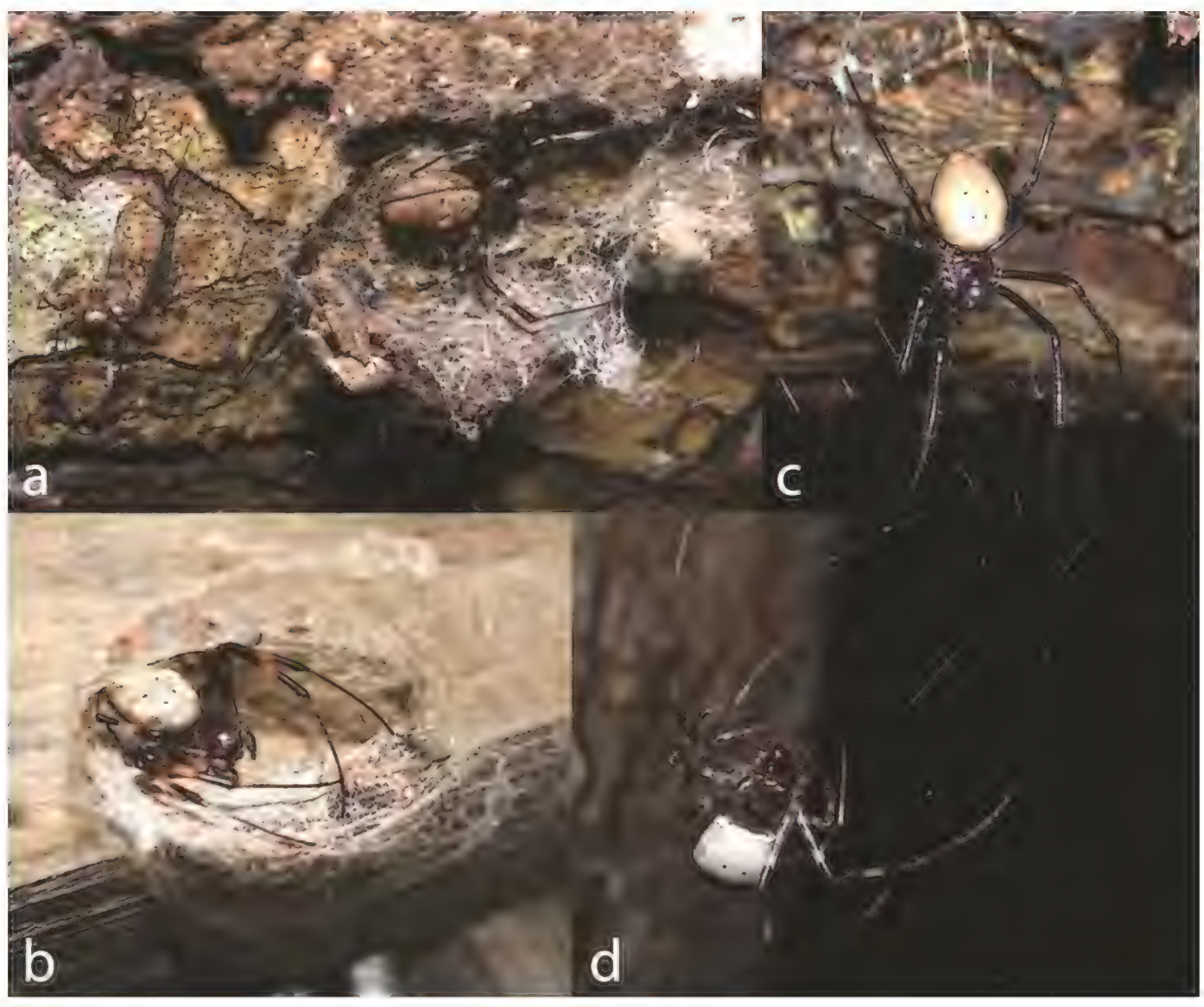

Fig. 8. *Nephilingis livida*. a. sexual dimorphism between the male, on the left, and the female, on the right. b-d. female. b. nesting. c. dorsal view. d. frontal view (c. is courtesy of Rémy Eudeline).

Genus ***Clitaetra*** Simon, 1889

- * *Clitaetra episinoides* Simon, 1889 is the first of the two species from Mayotte described by Simon (1889a). It is one of the 6 species of genus *Clitaetra* collected in Africa, Madagascar, and Sri Lanka. It has been recorded only from the Comoros Islands by Simon (1889a). Several individuals have been observed in the Mount Bénara forest; Fig. (9) shows two different individuals on their characteristic web parallel to a tree trunk.

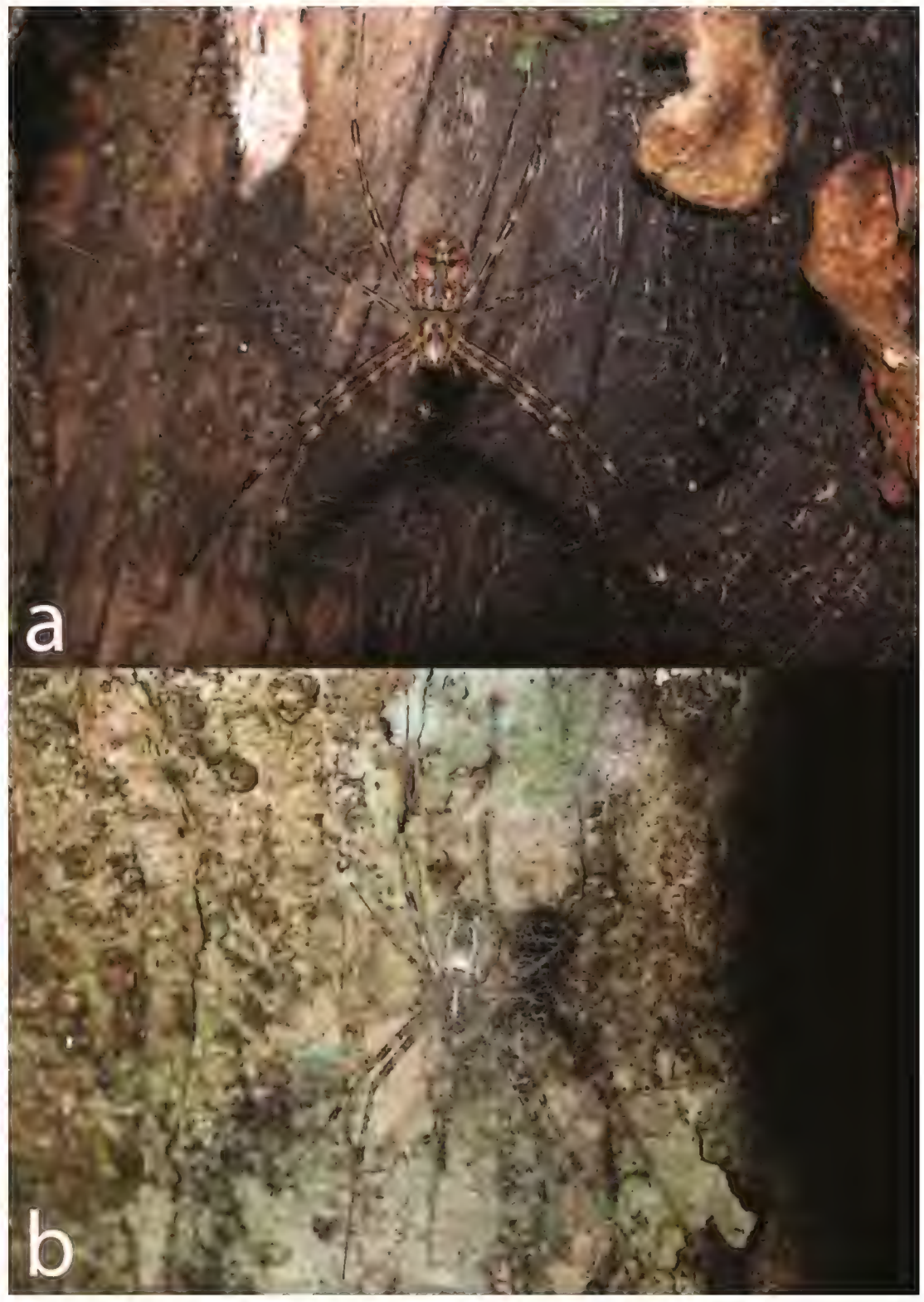

Fig. 9. *Clitaetra episinoides*. a. dorsal view. b. ventral view (J. Roger).

Genus ***Gasteracantha*** Sundevall, 1833

Gasteracantha rhomboidea comorensis Strand, 1916

This common spider exhibiting an uncommon shape and colour pattern has been reported by Strand (1916) in Mayotte and is precisely described by Emerit (1974). It is locally known as a kite-spider as it moves from the centre of its web along one of its threads like a kite when someone touches it.

A lot of individuals have been easily encountered in lots of different environments all around the island (forest, garden, town, etc.). There are different shades of colour from white to yellow (Figs. 10a,b). The ventral surface is black with yellow dots (Fig. 10c). Juvenile individuals show shorter length and reddish colour of their abdomen prominent spines (Fig. 10d). As *Nephila comorana*, this species is protected by French legislation on endangered species.

Fig. 10. *Gasteracantha rhomboidea comorensis*. a. dorsal view, colour variation white. b. dorsal view, colour variation yellow. c. ventral view. d. juvenile (J. Roger).

Fig. 11. *Cyclosa* sp. a. J. Roger. b, c, d. courtesy of Rémy Eudeline.

Genus ***Cyclosa*** Menge, 1866

- *Cyclosa insulana* (Costa, 1834): the individuals observed in Mayotte and shown in Fig. (11) strongly resemble *C. insulana*, which has a wide distribution area from southern Europe to south-eastern Asia and could have been easily brought there by boat or plane if not by natural ways.

Fig. (11) shows four different individuals found on Mayotte Island. Adding to the fact that these spiders correspond to the description of the genus by Menge (1866), they present also a characteristic web decoration often made with prey debris helping the spider to hide from predators.

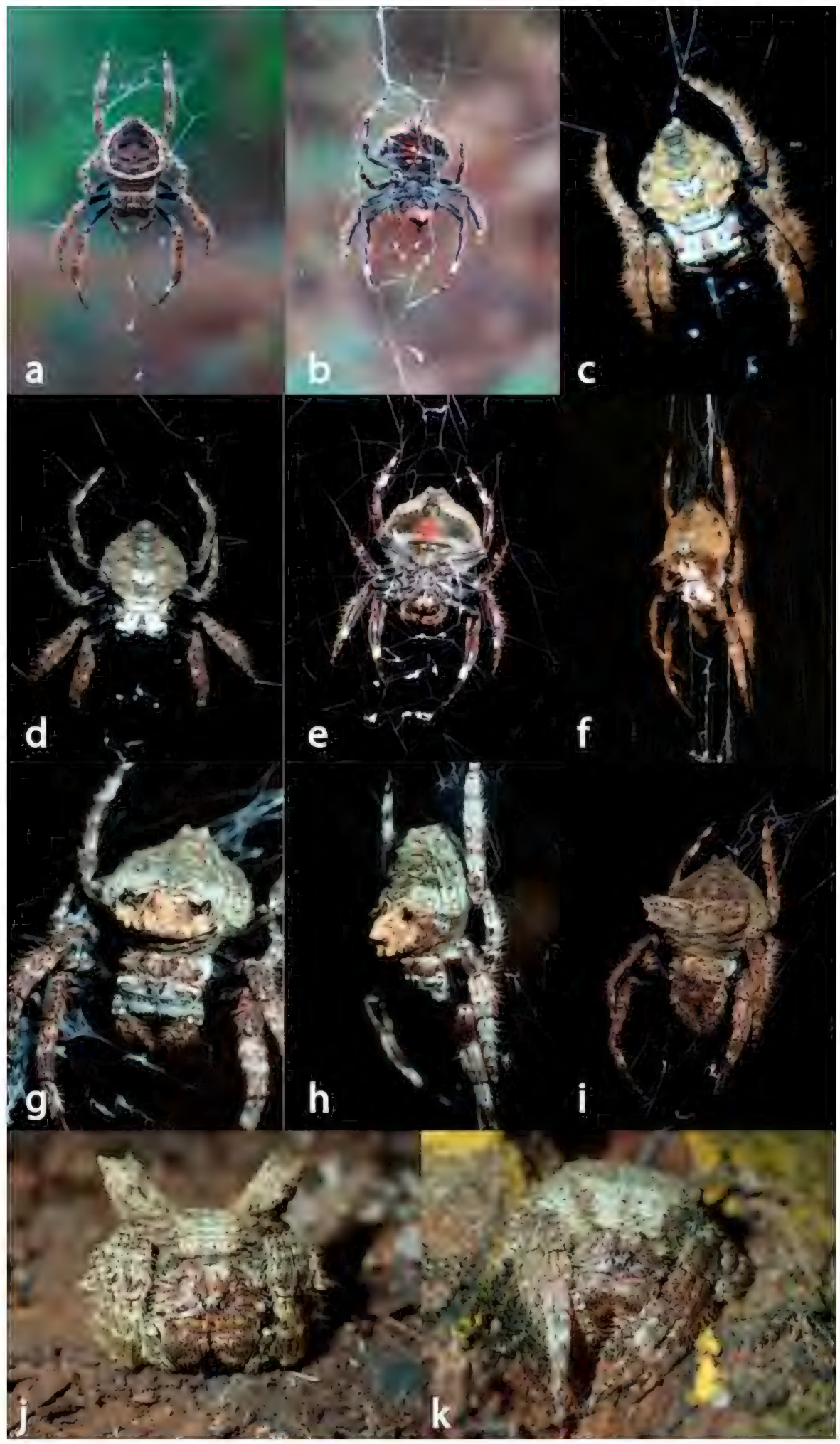

Fig. 12. *Caerostris* sp. a-b. dorsal and ventral views of the same individual. c-k. different morphospecies living on Mayotte Island. (a, b, i: J. Roger; d, e, f, g, h, j, k: courtesy of Rémy Eudeline).

Genus ***Caerostris*** Thorell, 1868

The two following bark spider species are reported from Mayotte:

- * *Caerostris mayottensis* Grasshoff, 1984 was described from a single sample (holotype conserved at Paris's Natural History Museum) from Mayotte by Grasshoff (1984).
- *Caerostris sexcuspidata* (Fabricius, 1793) was described another time by Grasshoff (1984) from a sample from Anjouan, Comoros. This one exhibits two horn-looking protuberances on the abdomen.

It is very difficult to know whether *C. sexcuspidata* reported from the Comoros could be found on Mayotte Is. in sympatry to *C. mayottensis* or not without sampling new individuals on the island and compare them accurately. Fig. (12) shows different individuals found on Mayotte and highlights the fact that there could be potentially at least two distinct species.

Genus ***Cyrtophora*** Simon, 1864

- *Cyrtophora citricola* (Forsskål, 1775) is also known as the tent-web spider. This species is widely distributed in tropical regions, but also in Europe around the Mediterranean. Its web is easily recognizable as it looks like a tent, and when they are living in group, sometimes all the webs together looks like a transparent Christmas tree. As shown on Fig. (13), *C. citricola*'s colouration has a wide range from black to orange, including grey, brown and even something pinkish.

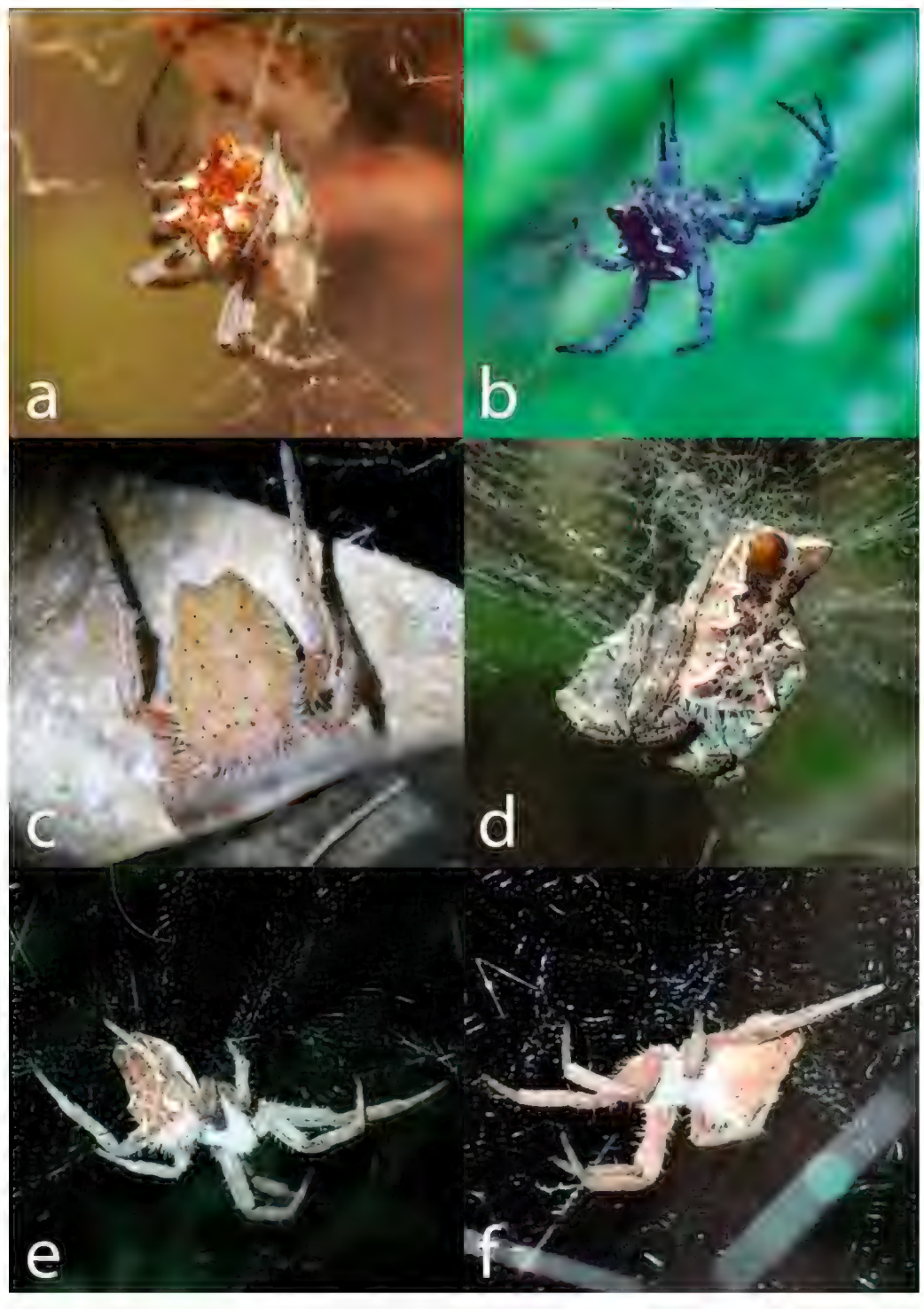

Fig. 13. *Cyrtophora citricola*, different colours (a: J. Roger; b-f: courtesy of Rémy Eudeline).

Genus ***Argiope*** Savigny, 1825

- *Argiope comorica* (Bjørn, 1997)

Only one Argiope species, *A. comorica*, has been described by Bjørn (1997) from Grande Comore, Comoros Is. depending on a female holotype collected by R. Jocqué in 1983. The only collected individual from Mayotte has been described by Jäger (2012); it was another female collected by R. Jocqué in 1998 and concluded it is the same species. Several Argiope individuals have been observed by Rémy Eudeline (Figs. 14a,b; R. Eudeline, pers. comm., 2018) and one has been observed at Malamani, Mayotte (GPS: 12.918794°S, 45.15979°E) on 14.vi.2018 by Alison Colombain during a field work of the French geological survey (A. Colombain, pers. comm., 2018). The spider's length is about 1cm and it is positioned in the middle of the web, with the *Argiope* characteristic X-shaped stabilimenta. Notice the uncommon spider's legs orientation bounded toward the "head".

Fig. 14. *Argiope comorica*, two different individuals on their X-shaped stabilimenta (Courtesy of Rémy Eudeline).

Fig. 15. Tetragnathidae from Mayotte. a. *Mesida thorelli* (Courtesy of Rémy Eudeline). b. *Leucauge* sp. (J. Roger).

Family **Tetragnathidae** Menge, 1866

Genus ***Leucauge*** White, 1841

During this study the author has found several *Leucauge* sp. in Mayotte. Further analysis of samples could help to identify clearly the species without any doubt. One of

those spiders is presented on Fig. (15b). The four following species have been found in the Comoros, and thus could be also found in Mayotte Is.:
- *Leucauge argyrescens* Benoit, 1978 has been reported from the Comoros (Locket, 1980; Schmidt & Krause, 1993) and the Seychelles.
- *Leucauge comorensis* Schmidt & Krause, 1993 is endemic to the Comoros Is. (Mayotte has not been investigated in the referred study).
- *Leucauge decorata nigricauda* Schenkel, 1944 was identified by Schmidt & Krause (1993) from Grande Comore. It was previously only reported from Timor.
- *Leucauge undulata* (Vinson, 1863) was identified by Schmidt & Krause (1993) from Grande Comore. It was already known from East Africa, including Madagascar and Rodriguez Is. (Mauritius).

Genus ***Mesida*** Kulczyński, 1911
- *Mesida thorelli* (Blackwall, 1877) was only reported from the Seychelles. It has been observed in Mayotte in Sada on 04.v.2006 (Christian Berquer, pers. comm., 2018) and also by R. Eudeline (Fig. 15a).

Genus ***Tetragnatha*** Latreille, 1804
At least two *Tetragnatha* species have been reported from the Comoros (Grande Comore and Mohéli only):
- *Tetragnatha boydi praedator* Tullgren, 1910
- *Tetragnatha strandi melanogaster* Schmidt & Krause, 1993

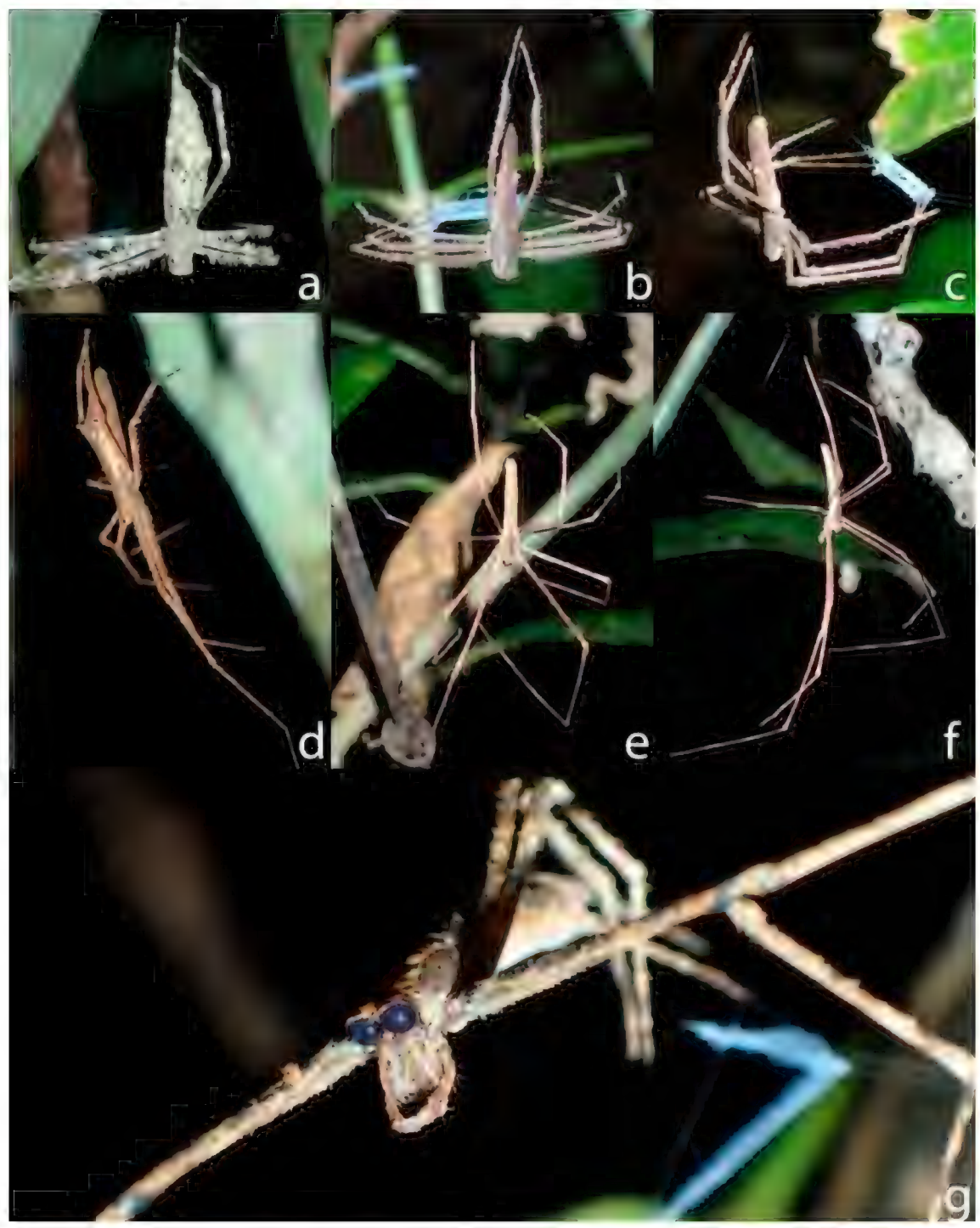

Fig. 16. *Deinopis* sp. from Mayotte (a-g: courtesy of Rémy Eudeline).

Deinopidae

Family **Deinopidae** C.L. Koch, 1850
Genus ***Deinopis*** MacLeay, 1839
This genus is easily recognizable especially because of the two big blue eyes of some species, being the biggest of the spider's world. Some individuals shown on Fig. (16) have been met in Mayotte (Rémy Eudeline, pers. comm., 2018) but it is difficult to identify the species without having samples: they could be already known from Madagascar (*D. madagascariensis* Lenz, 1886) or East Africa (*D. cornigera* Gerstäcker, 1873) or they could be a new species, maybe endemic in Mayotte or at least in the Comoros.

Oecobioidea

Family **Hersiliidae** Thorell, 1870
Genus ***Hersilia*** Savigny, 1825
- *Hersilia* sp.: There is apparently only one species found on Mayotte Is., reported by Jocqué & Dippenaar-Schoeman (2007) first and observed several times by Rémy Eudeline (pers. comm., 2018) and by the author on 21.vi.2018 at Coconi's botanical garden (45.134153°E, 12.834278°S). Several species have been collected from the Comoros: *H. aldabrensis* Foord & Dippenaar-Schoeman, 2006 and *H. madagascariensis* (Wunderlich, 2004), and one has been described from Moheli (Comoros): *H. moheliensis* Foord & Dippenaar-Schoeman, 2006. The individuals from Mayotte observed by the author and by Rémy Eudeline are shown on Fig. (17). All of them show the typical posterior spinnerets more or less as long as the abdomen.

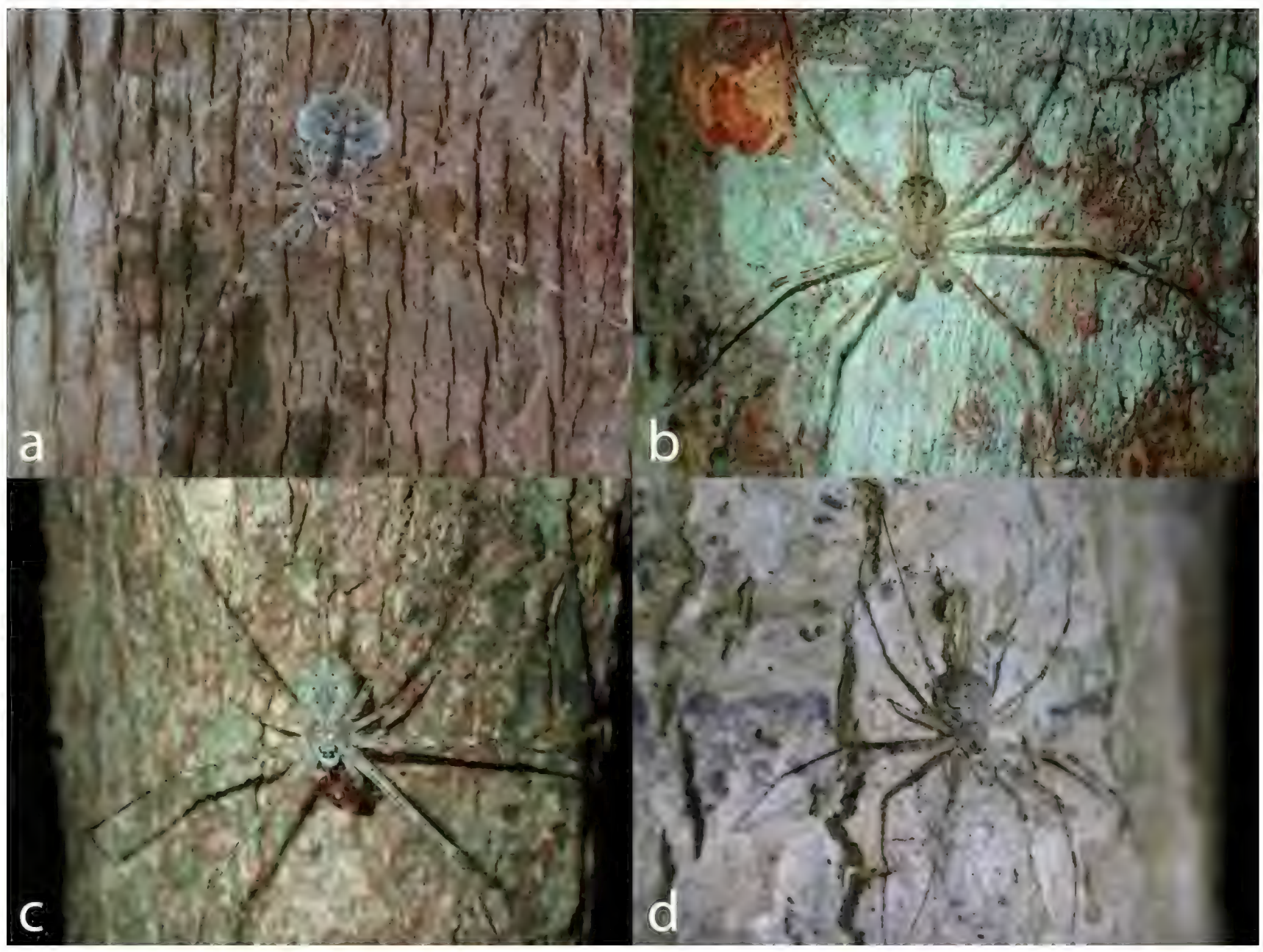

Fig. 17. *Hersilia* sp. from Mayotte (a: J. Roger; b-d: courtesy of Rémy Eudeline).

Zodarioidea

Family **Zodariidae** Thorell, 1881
Genus ***Asceua*** Thorell, 1887
- *Asceua radiosa* Jocqué, 1986 was described after individuals from Grande Comore.
Genus ***Diores*** Simon, 1893
- * *Diores filomenae* Jocqué, 2003 was described after individuals from Mayotte.

Desidae

Family **Desidae** Pocock, 1895
Genus ***Desis*** Walckenaer, 1837
- *Desis crosslandi* Pocock, 1903: this species has been only reported and collected in Tanzania and Madagascar but neither in Mayotte, nor in the Comoros. Dr. Frédéric Ducarme from Mayotte University (CUFR) has collected it at low tide on the fringing reef at Sohoa, Mayotte central-east coast on 31.i.2018 (Fig. 18a, F. Ducarme, pers. comm., 2018). Fig. (18b) shows a living individual from Moya 2's mangrove, on Petite-Terre on 24.viii.2013 (Norbert Verneau, pers. comm., 2018).

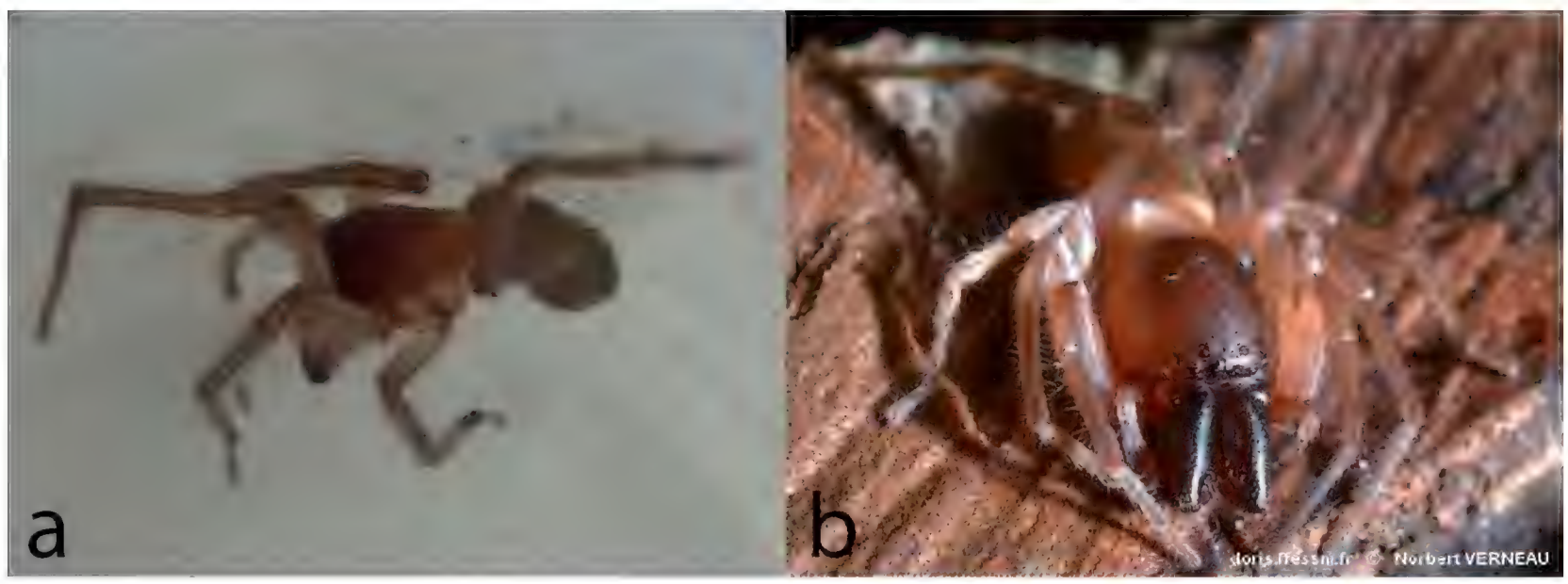

Fig. 18. *Desis crosslandi* (a: courtesy of Frédéric Ducarme – CUFR sample; b: courtesy of Norbert Verneau).

Fig. 19. *Heteropoda venatoria*. a. male. b. female (J. Roger).

Sparassidae

Family **Sparassidae** Bertkau, 1872
Genus ***Heteropoda*** Latreille, 1804

- *Heteropoda venatoria* (Linnaeus, 1767): Althought it has never been scientifically reported from Mayotte, this species of huntsman spider locally called "babouk" is very often present in houses or nearby. Female could be as long as 3 cm. Fig. (19) shows a male (a) observed in Majicavo Lamir (45.229652°E, 12.754125°S) on 18.ii.2018, and a female (b) observed at Ngouja (45.085542°E, 12.961794°S) on 13.i.2018.

Fig. 20. Sparassidae (a-c: J. Roger; d: Rémy Eudeline).

Other sparassids have also been observed (some example on Fig. 20), especially on the leaves of ylang-ylang trees in Combani, but pictures only do not help for identification of the species.

Oval calamistrum clade

Family **Oxyopidae** Thorell, 1870
Genus ***Peucetia*** Thorell, 1869
Two *Peucetia* species are sympatric in the Comoros according to the work of Niekerk & Dippenaar-Schoeman (1994):
- *Peucetia lucasi* (Vinson, 1863): Strand (1916) confirmed the presence of this species in the Comores in general and in Mayotte in particular, sampling two females. One individual has been observed at Mahabou's Point (45.237382°E, 12.781913°S) by the author on 02.vii.2018 (Fig. 21a).
- *Peucetia madagascariensis* (Vinson, 1863): Fig. (21b) shows an individual observed by Rémy Eudeline. Its presence in Mayotte has been attested by the accurate work on several samples of Niekerk & Dippenaar-Schoeman (1994). These authors presented in detail the differences between the two species; *P. lucasi* shows clypeal lines that *P. madagascariensis* has not and they also exhibit differences concerning the trochanters colours and the abdomen patterns.

Fig. 21. *Peucetia*. a. *Peucetia lucasi* ♂ (By J. Roger).
b. *Peucetia madagascariensis* ♀ (Courtesy of Rémy Eudeline).

Family **Pisauridae** Simon, 1890
Genus ***Nilus*** O. Pickard-Cambridge, 1876
- *Nilus majungensis* (Strand, 1907) – The INPN indicates it is present on Mayotte (https://inpn.mnhn.fr/espece/cd_nom/645554) but Strand only reported it from Madagascar.

Fig. 22. *Hygropoda* sp. from Mayotte (J. Roger).

Genus ***Hygropoda*** Thorell, 1894
- One *Hygropoda* sp. has been observed at Karihani Lake, Combani (45.121489°E, 12.797088°S) on 16.vi.2018 (Fig. 22).

It is difficult to determine whether it is an endemic species or not. It is interesting to notice that there are at least three species reported from Madagascar: *H. linearis* (Simon, 1903), *H. madagascarica* Strand, 1907 and *H. Tangana* (Roewer, 1955).

Family **Lycosidae** Sundevall, 1833
Genus ***Wadicosa*** Zyuzin, 1985
- * *Wadicosa jocquei* Kronestedt, 2015 has been recorded for the first time from Mayotte.

Family **Thomisidae** Sundevall, 1833
Genus ***Geraesta*** Simon, 1889
- *Geraesta hirta* Simon, 1889 has been reported from Grande Comores (Benjamin, 2015). There is actually no species recorded from Mayotte. We present here a species found several times on the island on Fig. (23).

Fig. 23. Thomisid species from Mayotte (J. Roger).

Dionycha

Family **Viridasiidae** Lehtinen, 1967 (Fig. 24)
Genus ***Vulsor*** Simon, 1889
- * *Vulsor bidens* Simon, 1889 is the second of the two species from Mayotte described by Simon (1889a).

Fig. 24. Viridasiidae from Mayotte (Courtesy of Rémy Eudeline).

Family **Salticidae** Blackwall, 1841

Fig. 25. Salticidae from Mayotte. a-b. *Plexippus petersi*. c-g, i. undetermined species. h. *Heliophanus* sp. j. *Portia schultzi* (a-e: J. Roger; f-i: courtesy of Rémy Eudeline; j: courtesy of Antoine Rouillé).

Dierkens (2010) presented a field observation of two species of Sparteinae of Mayotte:
- *Cyrba legendrei* Wanless, 1984
- *Veissella milloti* Logunov & Azarkina, 2008
Dierkens (2014) described two new Salticidae from Mayotte:
- * *Asemonea bimaculata* Dierkens, 2014
- * *Padilla rhizophorae* Dierkens, 2014
Dierkens (2012) presented two salticids of the genus *Heliophanus* found in Mayotte:
- *Heliophanus excentricus* Ledoux, 2007
- *Heliophanus hamifer* Simon, 1886
and described a new species:
- *Heliophanus comorensis* Dierkens, 2012

Pictures only cannot help to determine exactly the species (Figs. 25c-g,i). The following species have not been collected in Mayotte but only photographed by scientists during field observations and clearly identified afterwards:

Genus ***Plexippus*** C.L. Koch, 1846
- *Plexippus petersi* (Karsch, 1878): originated from Asia, this spider has been introduced in Africa and the Pacific Islands. It has been observed several times in Mayotte (Figs. 25a,b).

Genus ***Portia*** Karsch, 1878
- Two species are reported from Madagascar and East Africa: *Portia africana* (Simon, 1886) and *Portia schultzi* Karsch, 1878. The individual observed by Antoine Rouillé and shown on Fig. (25j) corresponds more to the description of *P. schultzi*.

Conclusion

This study should be considered as a first attempt to list the known species from Mayotte Island, Comoros Archipelago, in a catalogue using the available bibliography and some pictures from different photographers. It allows to group herein species already reported from Mayotte (separately) or having been described in Mayotte firstly. Also, the author tried to identify some individuals, or at least to attribute a genus, with the help of studies from nearby places like the other islands of the Comoros (Grande Comore, Mohéli, Anjouan), Madagascar, the Seychelles or even East Africa. Further accurate field study should be done all around the island and its dependences to complete this work.

Acknowledgments

The author is very grateful to Didier Petot and Christian Berquer from the French web forum www.insecte.org for their precious help for the identification of several spiders from Mayotte. He is also very grateful to Remy Eudeline, Norbert Verneau, and Antoine Rouillé for sharing their numerous high quality pictures, with Dr. Frédéric Ducarme for sharing the information about the picking of *Desis crosslandi* on the fringing coral reef at Sohoa for the marine species collection of Mayotte University (CUFR) and R. Jocqué for sharing his article about Zodariidae species. He also would like to thank Prof. Platnick, and his successors, for his incredible World Spider Catalog which represents a goldmine of historic references about spiders as well as the French national history museum (MNHN) for the INPN list of spider species from Mayotte. Finally he would like to thank Valérie Pomiès for the proofreading and the Editor for the final review and edition processes.

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Serket (2018) vol. 16(3): 133-160.

Spiders (Arachnida: Araneae) of Jazirat Shandweel District, Sohag Governorate, Egypt

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Abstract

This study gives highlights on the biodiversity of spiders in an olive trees orchard, a lemon trees orchard, and webs of *Cyrtophora citricola* at Jazirat Shandweel District, Sohag Governorate, Egypt. In addition, it gives a preliminary list of spiders based on the main taxonomic characters. The sampling was carried out weekly or monthly during the period: September, 2015 to January, 2018 using the beating net and hand picking methods. A total of 6237 individuals were collected, identified, and classified into: 30 species belonging to 29 genera and 21 families; among them, three families, 18 genera, and 11 species are listed in addition to other unidentified species.

Keywords: Araneae, Biodiversity, Identification, Sohag Governorate, Taxonomic keys.

Introduction

Araneae is one of the common arthropod groups that are characterized by its well modified appendages, as well as spinnerets, silk glands, venom glands, male modified palps (sperm transfer organs), and fusion of the abdominal segments (Coddington & Levi, 1991).

Spiders are considered as a buffer to prevent pest populations from attaining critical levels and good bio-indicators of anthropogenic disorder of the field research (Kaltsas *et al*., 2014; Ossamy *et al*., 2016). This remarkable role is due to their sensitivity to all environmental circumstances, their high number of individuals and species and their tendency to subsist in different ecosystems (Kajak *et al*., 2000; Lewinsohn *et al*., 2005). In addition to the existence of variation of body size and different predatory behaviours, which increase the chance of being faced with the target prey (Riechert & Bishop, 1990; Young & Edwards, 1990; Nyffeler *et al*., 1994 a, b; Wise, 1993).

According to the World Spider Catalog (2018), there are more than 47700 species detected in the world belonging to 118 families and more than 4100 genera. Many studies were dealt with the biology of spiders and its diversity in different Egyptian Governorates (El-Mahalawy, 1988; Rahil, 1988; Sallam, 1996, 2002; Hussein, 1999; Medany, 2013; El-Erksousy, 2000; Ibrahim, 2003, 2008; Hamada, 2003, 2008; Ahmed, 2003, 2009; Shaban *et al*., 2008; Mohammed, 2009; El-Gendy, 2016; Zaher, 2016). Recently, El-Hennawy (2017a) reported the presence of 41 families classified into 204 genera and 405 species in Egypt.

In Upper Egypt, few studies were focused on identification and biodiversity of spiders including Qena Governorate (Hussien, 2011; Obuid-Allah *et al*., 2015a,b; Obuid-Allah *et al*., 2018), Assiut Governorate (Ahmed, 2012; Obuid-Allah *et al*., 2017; Rashwan, 2017), and Elba, Red Sea (Abdelhafez *et al*., 2016). In Sohag Governorate, only Mohafez (2000) and Mohafez *et al.* (2010) studied the biodiversity of spiders.

Therefore, the present study was carried out to give highlights on the biodiversity of spiders in an olive trees orchard, a lemon trees orchard and webs of *Cyrtophora citricola* (Forskål, 1775) at Jazirat Shandweel District, Sohag Governorate. In addition to that, it presents a preliminary checklist of the spiders at the studied sites with taxonomic keys.

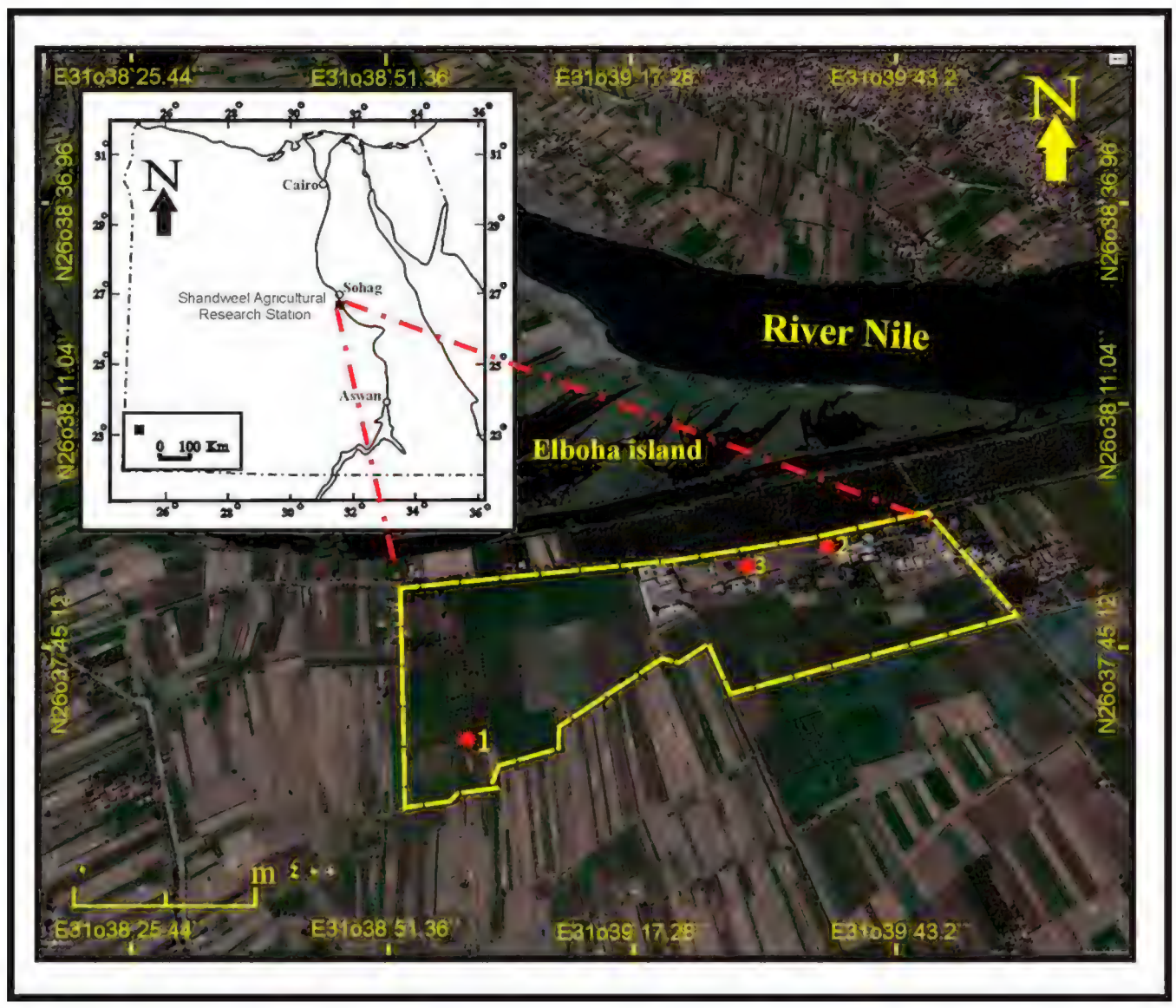

Fig. 1. A map showing the studied site at Jazirat Shandweel District, Sohag Governorate, Egypt.

Material and Methods

Sampling of spiders was carried out during a period of about three years (from September, 2015 until January, 2018) in three different habitats at Jazirat Shandweel District (26°37'59"N, 31°39'10"E), Sohag Governorate (Fig. 1). Two sampling methods were used in this study, hand picking and beating trays methods. In the laboratory, both males and females from each species were separated, photographed, and preserved in

labelled bottles containing 70% ethyl alcohol. The different taxonomical organs were removed using micro-scissor and fine sharpened needles under a stereomicroscope. They were cleared in clove oil or in lactic acid and mounted on slides using Hoyer's media. Identification of the collected species was carried out according to the keys and descriptions of Petrunkevitch (1939), Levi & Levi (1968), Dippenaar-Schoeman & Jocqué (1997), Jocqué & Dippenaar-Schoeman (2006), and El-Hennawy (2017b). The confirmation of spider's identification was done by communication with Mr. Hisham El-Hennawy (the Egyptian expert in the identification of Egyptian spiders).

Abbreviations used: A.M.E. = Anterior median eyes, ana.tu. = Anal tubercle, an. spi. = Anterior spinnerets, bl. = Bulge, ca. = Calamistrum, cla. = Claw, cly. = Clypeus, col. = Colulus, con. = Conductor, cop. op. = Copulatory opening, cox. = Coxa, c.r. = Cephalic region, cr. = Cribellum, cy. = Cymbium, Cyr. webs = *Cyrtophora citricola* webs, e. = Embolus, en. = Endite, fa. = Fang, fe. = Femur, fl. = Flange, fo. = Fovea, g.pl. = Genital plate, ke. = Keel, l. = Labium, lu.b. = Lung books, ma. = Macro-setae, me.apo. = Median apophysis, me.spi. = Median spinnerets, met. = Metatarsus, o.ar. = Ocular area, pa. = Patella, par.cy. = Paracymbium, pe. = Pedipalp, po.spi. = Posterior spinnerets, s. = Scopula, sc. = Scape, sep. = Septum, spi. = Spinnerets, spu. = Spur, st. = Stabilimentum, ste. = Sternum, ta. = Tarsus, te. = Teeth, teg. = Tegulum, th.r. = Thoracic region, ti. = Tibia, tr. = Trochanter.

Results

A total number of 5739 individuals of various species were collected from orchards of olive and lemon trees, in addition to that inhabit the webs of *Cyrtophora citricola*. They belong to thirty species, twenty nine genera, twenty one families and one

Table 1. Numbers of families, genera, and species recorded at the studied area during the study period: September, 2015 - January, 2018.

Series	Family	No. of genera	No. of species
1	Agelenidae	1	1
2	Araneidae	5	5
3	Cheiracanthiidae	1	1
4	Dictynidae	1	1
5	Eresidae	1	1
6	Filistatidae	1	1
7	Gnaphosidae	1	1
8	Hersiliidae	1	1
9	Linyphiidae	1	1
10	Lycosidae	1	1
11	Oecobiidae	1	1
12	Oonopidae	1	1
13	Oxyopidae	1	1
14	Philodromidae	2	2
15	Pholcidae	1	1
16	Salticidae	4	4
17	Synaphridae	1	1
18	Theridiidae	1	1
19	Thomisidae	2	2
20	Titanoecidae	1	1
21	Uloboridae	1	1
Total	21	**29**	**30**

Table 2. The number of individuals within each collected species at the studied areas during the study period: September, 2015- January, 2018.

Family / Genus / Species		Olive trees	Lemon trees	Cyr. webs
Family 1: **Agelenidae** C.L. Koch, 1837		9	-	-
	Benoitia sp.	9	-	-
Family 2: **Araneidae** Clerck, 1757		325	81	548
	Argiope trifasciata (Forskål, 1775)	36	-	40
	Cyrtophora citricola (Forskål, 1775)	82	19	500
	Larinia chloris (Savigny, 1825)	101	-	2
	Neoscona subfusca (C.L. Koch, 1837)	106	62	-
	Unidentified species [Plate 12B, 12C]	-	-	6
Family 3: **Cheiracanthiidae** Wagner, 1887		510	236	16
	Cheiracanthium isiacum O. Pickard-Cambridge, 1874	510	236	16
Family 4: **Dictynidae** O. Pickard-Cambridge, 1871		127	35	-
	Dictyna sp.	127	35	-
Family 5: **Eresidae** C.L. Koch, 1845		-	-	2
	Stegodyphus dufouri (Audouin, 1825)	-	-	2
Family 6: **Filistatidae** Ausserer, 1867		5	-	-
	Filistata sp.	5	-	-
Family 7: **Gnaphosidae** Pocock, 1898		109	120	7
	Poecilochroa pugnax (O. Pickard-Cambridge, 1874)	109	120	7
Family 8: **Hersiliidae** Thorell, 1870		103	-	-
	Hersilia caudata Savigny, 1825	103	-	-
Family 9: **Linyphiidae** Blackwall, 1859		32	153	-
	Sengletus extricatus (O. Pickard-Cambridge, 1876)	32	153	-
Family 10: **Lycosidae** Sundevall, 1833		35	3	-
	Pardosa sp.	35	3	-
Family 11: **Oecobiidae** Blackwall, 1862		-	-	2
	Uroctea sp.	-	-	2
Family 12: **Oonopidae** Simon, 1890		7	-	-
	Orchestina sp.	7	-	-
Family 13: **Oxyopidae** Thorell, 1870		-	4	-
	Oxyopes sp.	-	4	-
Family 14: **Philodromidae** Thorell, 1870		374	69	6
	Pulchellodromus glaucinus (Simon, 1870)	239	69	-
	Thanatus albini (Audouin, 1825)	135	-	6
Family 15: **Pholcidae** C.L. Koch, 1850		10	-	20
	Holocnemus pluchei (Scopoli, 1763)	10	-	20
Family 16: **Salticidae** Blackwall, 1841		1236	146	-
	Afraflacilla spiniger (O. Pickard-Cambridge, 1872)	299	57	-
	Bianor albobimaculatus (Lucas, 1846)	57	-	-
	Heliophanillus fulgens (O. Pickard-Cambridge , 1872)	301	64	-
	Thyene imperialis (Rossi, 1846)	579	25	-
Family 17: **Synaphridae** Wunderlich, 1986		81	-	-
	Synaphris sp.	81	-	-
Family 18: **Theridiidae** Sundevall, 1833		232	789	15
	Theridion spinitarse O. Pickard-Cambridge, 1876	232	789	15
Family 19: **Thomisidae** Sundevall, 1833		207	18	-
	Runcinia grammica (C.L. Koch, 1837)	39	-	-
	Thomisus spinifer O. Pickard-Cambridge, 1872	168	18	-
Family 20: **Titanoecidae** Lehtinen, 1967		2	-	-
	Nurscia sp.	2	-	-
Family 21: **Uloboridae** Thorell, 1869		251	75	255
	Uloborus walckenaerius Latreille, 1806	251	75	255

Dominance structure: Most dominant: 550-1236, Abundant: 401-540, Frequently abundant: 201-400, Occasional: 86-200, and Rare: 0-85.

Infra-order, Araneomorphae. These families are: Agelenidae, Araneidae, Cheiracanthiidae, Dictynidae, Eresidae, Filistatidae, Gnaphosidae, Hersiliidae, Linyphiidae, Lycosidae, Oecobiidae, Oonopidae, Oxyopidae, Philodromidae, Pholcidae, Salticidae, Synaphridae, Theridiidae, Thomisidae, Titanoecidae, and Uloboridae (Table 1).

The most diverse families were Araneidae and Salticidae that are represented by 5 and 4 species, respectively, followed by the Philodromidae and Thomisidae with two species each. While the rest of families were represented by only a single species.

The most dominant families (number of individuals: 550-1236) were: Salticidae, Theridiidae, Araneidae, Cheiracanthiidae, and Uloboridae, respectively. The abundant family (no. of individuals: 401-540) was Philodromidae and the frequently abundant families (no. of individuals: 201-400) were: Gnaphosidae and Thomisidae. Linyphiidae and Hersiliidae were found to be occasional (no. of individuals: 86-200). On the other hand, the rare families (no. of individuals: 0-85) were: Synaphridae, Dictynidae, Lycosidae, Pholcidae Agelenidae, Oonopidae, Filistatidae, Oxyopidae, Eresidae, Oecobiidae, and Titanoecidae, respectively (Table 2).

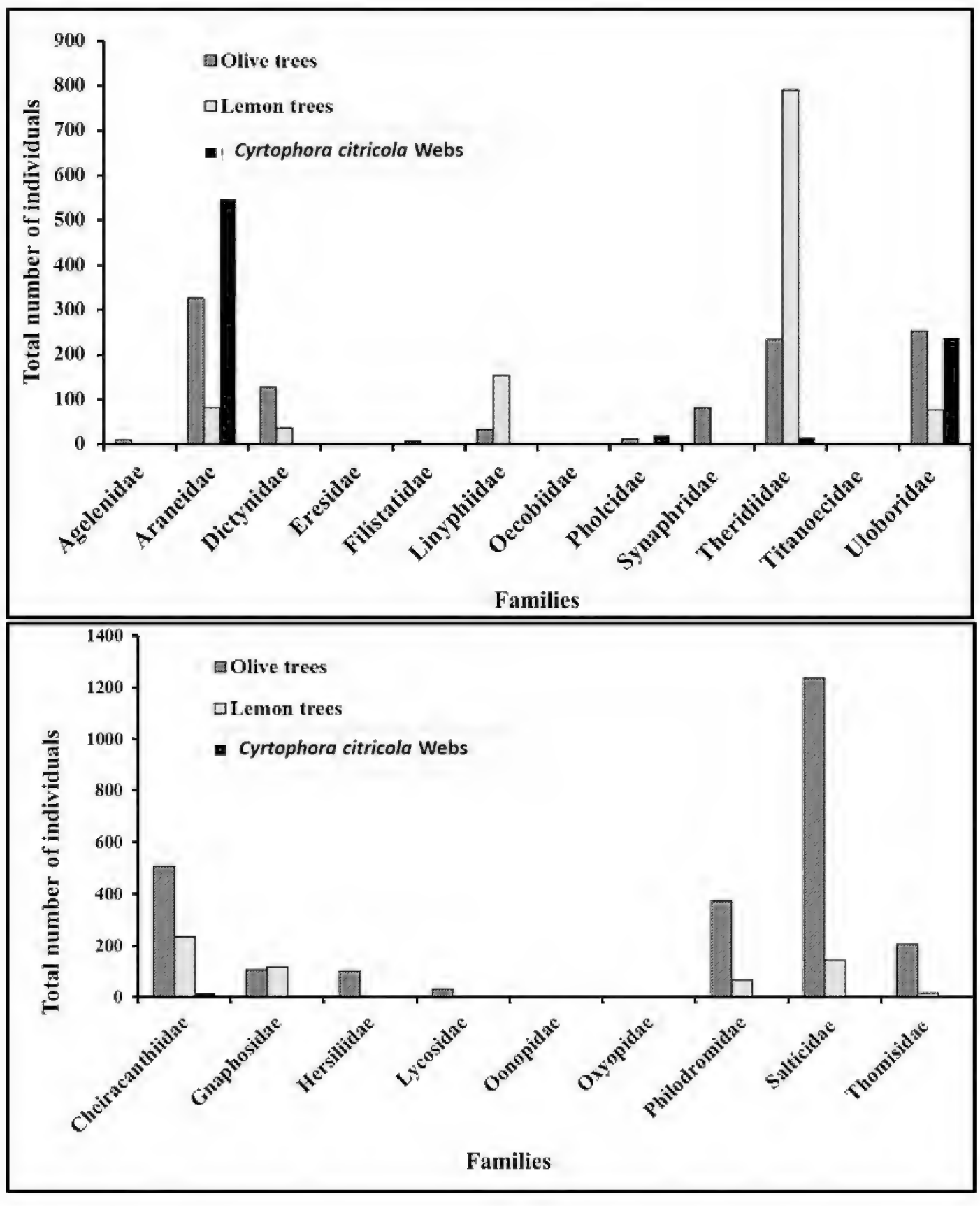

Fig 2. Number of individuals of each recorded family.

Data in Table (2) and Fig. (2) show that the families: Araneidae, Cheiracanthiidae, Gnaphosidae, Philodromidae, Theridiidae, and Uloboridae were present in all localities with relatively high numbers. The variation among the surveyed localities in relation to the number of the collected individuals and the host were presented as follows:

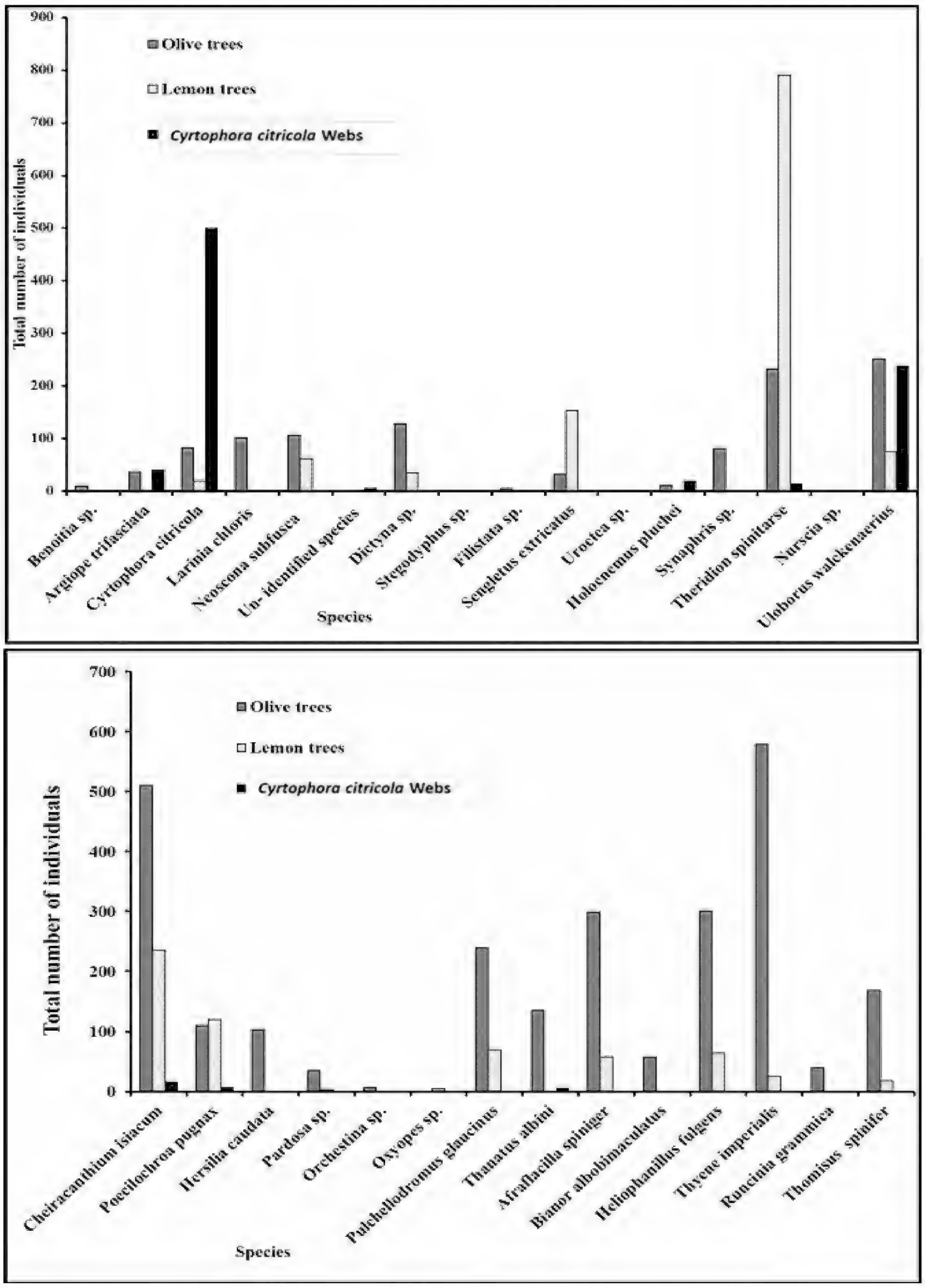

Fig. 3. Number of individuals of each recorded species.

1. Olive orchard: The most dominant family is Salticidae with 1236 individuals, followed by the abundant family, Cheiracanthiidae (510 individuals). While, Araneidae, Philodromidae, Uloboridae, Theridiidae and Thomisidae, that were represented by 325, 374, 251, 232, and 207, respectively, were frequently abundant. Dictynidae,

Gnaphosidae, Hersiliidae, and Synaphridae (127, 109, 103, and 81, respectively) were considered occasional. The rest of the families: Lycosidae, Linyphiidae, Pholcidae, Agelenidae, Oonopidae, Filistataidae, and Titanoecidae (35, 32, 10, 9, 7, 5, and 2, respectively) are considered rare. On the other hand, *Thyene imperialis* and *Cheiracanthium isiacum* were the most abundant species with 579 and 510 individuals, respectively, followed by *Heliophanillus fulgens*, *Afraflacilla spiniger*, *Pulchellodromus glaucinus*, and *Theridion spinitarse* (the abundant). The rest of the species can be described as frequently abundant, occasional and rare (Table 2 and Fig. 3).

2. Citrus orchard (Lemon trees): The most dominant family was Theridiidae and represented by 789 individuals, followed by Cheiracanthiidae with 236 individuals (the abundant). However, the frequently abundant families were Linyphiidae, Salticidae, and Gnaphosidae and represented by 153, 146, and 120, respectively. The rest of the families: Araneidae, Uloboridae, Philodromidae, Dictynidae, Thomisidae, Lycosidae, and Oxyopidae that were represented by 81, 75, 69, 35, 18, 3, and 4, respectively) are considered rare. The most dominant species is *Theridion spinitarse* comprising 789 individuals followed by *Cheiracanthium isiacum* with 236 individuals. The two families, Lycosidae and Oxyopidae are considered rare where each of which is represented by less than five individuals during the course of the investigation.

3. *Cyrtophora* webs: These webs were built by the females of *Cyrtophora citricola*. In these webs, other species of Araenidae and species of other families as: Uloboridae, Theridiidae, Pholcidae, Philodromidae, Oecobiidae, Gnaphosidae, Eresidae, and Cheiracanthiidae were existing. The frequently abundant family was Uloboridae and represented by 255 individuals. While the rest families are rare, represented by few individuals.

Key to Spider Families of Jazirat Shandweel District

1. Anal tubercle large, abnormal in shape with a fringe of long curved setae (Plate 1C). Small to medium sized spiders found under multilayered mesh-webs over cracks or crevices (Plates 1A, 1B). Carapace is semi-circular in shape ..... **Oecobiidae**
- Anal tubercle is normal in shape, without long setae 2

2. Spiders that have a cribellum and calamistrum (reduced or absent in males) (Plate 1D) ..... (Cribellate spiders) 3
- Spiders that have no cribellum and calamistrum (Plate 1E) ..... (Ecribellate spiders) ... 7

3. Eyes are in a compact group on a slight hump (Plate 2A), carapace is narrowed anteriorly; spinnerets are advanced, located ventrally instead of terminally (Plate 2C); labium is fused to sternum (Plate 2B); calamistrum is short (Plate 2D); medium sized spiders that live in silk tubular retreats made in crevices, in rocks or barks of the trees (Plate 1F); haplogyne ..... **Filistatidae**
- Eyes, spinnerets and carapace not as above; labium not fused to sternum; entelegyne .. 4

4. Femora with rows of long trichobothria; metatarsi IV usually compressed and curved under line of calamistrum (Plate 3B); first pair of legs is obviously longer than second pair (Plate 3A); small sized spiders and spin fully orb webs or sectors of webs in different shapes (Plates 3C, 3D); abdomen with two anterior humps ..... **Uloboridae**
- Femora without rows of long trichobothria; metatarsi IV not compressed and curved; first pair of legs not longer than second pair 5

5. Carapace is rectangular (Plate 2F); ocular area long, anterior lateral eyes and posterior lateral eyes more than four times their diameter apart; medium sized spiders with a velvety texture and appearance (Plate 2E) ..... **Eresidae**
- Carapace narrowed in front; ocular area shorter, anterior lateral eyes and posterior lateral eyes less than four times their diameter apart 6

6. Endites parallel; abdomen is dark, with four white spots in two rows, the anteriors are larger than the posteriors (Plate 3E); small to medium sized spiders with rectangular carapace and two straight eye rows, each having four eyes (Plate 3F) ..... **Titanoecidae**
- Endites converging; abdomen is longer than wide and has a dark demarcation (Plate 4B) on pale background; small sized spiders that build irregular mesh webs between two leaves (Plate 4A) ..... **Dictynidae**

7. Spiders have six eyes; small sized spiders, total body length of adult <5 mm; female pedipalps are without claws (Plate 4C); eyes grouped closely together; posterior median eyes are irregular in shape (Plate 4D) ..... **Oonopidae**
- Spiders have eight eyes 8

8. Leg tarsus with two claws 9
- Leg tarsus with three claws 13

9. Eyes are arranged in three rows (4:2:2) (Plate 7C), anterior median eyes are very large (Plate 7D); jumping spiders that walk with short, jerky hops (Plate 8D) ..... **Salticidae**
- Eyes differently arranged 10

10. First and second pairs of legs are laterigrade (projecting to both sides) 11
- Legs are prograde (First and second pairs directed forward, fourth pairs directed backward and the third one varies) 12

11. Tarsi and metatarsi are without scopulae (Plates 5B, 5C); first and second pairs of legs are usually longer than the third and fourth ones; Spiders with a crab-like appearance that are sitting motionless on flowers and branches of trees (Plate 5A); body hairs are simple and erected (Plate 5B) ..... **Thomisidae**
- Claw tufts composed of spatulate hairs and the tarsi of the first and second pairs of legs are scopulate (Plate 5F); legs not as above; medium-sized, running crab spiders, with leaf shaped heart marks on their abdomens; tarsus and metatarsus allow movement in one plane only (Plate 5D); body hairs are feathery (Plate 5E) ..... **Philodromidae**

12. Posterior median eyes oval and pale; endites obliquely depressed; anterior spinnerets are long, cylindrical, and widely separated from each other (Plate 6B), one-segmented; hunting spiders, that rest on the retreats of curled leaves (Plate 6A) ..... **Gnaphosidae**
- Posterior median eyes usually round; endites not obliquely depressed; anterior spinnerets conical, not widely separated; posterior spinnerets are distinctly two-segmented and the distal segment is conical (Plates 7B, 7C); medium sized spiders that build thin, small oval purse within rolled-up leaves (Plate 7A) ..... **Cheiracanthiidae**

13. Tiny sized spiders, body length is less than two mm (Plate 8E); metatarsi have same length or shorter than tarsi (Plate 9A); chelicerae with toothed keel instead of the usual teeth (Plate 8F) ..... **Synaphridae**

- Larger spiders or if tiny, metatarsi longer than tarsi 14

14. Tarsi with trichobothria, often in a row 15
- Tarsi without trichobothria 17

15. Eyes in two rows; posterior spinnerets are conical in shape, slender; two-segmented with an apical segment narrowing towards its tip (Plate 6D); medium sized spiders that are living in sheet webs with a funnel near the sheet corner (Plate 6C) ..... **Agelenidae**
- Eyes either in 3 to 4 rows (4:2:2, 2:4:2 or 2:2:2:2) or in three groups 16

16. Clypeus is very high (Plate 8B); posterior eyes and anterior lateral eyes are forming a hexagonal group behind the small anterior median eyes (Plate 8B); there are numerous long spines on tibiae and metatarsi of legs (Plate 8B); medium to small sized spiders with high convex carapace (Plate 8A) ..... **Oxyopidae**
- Clypeus not as high; eye pattern (4:2:2) (Plate 7F); setae on legs different; medium to large sized hunting spiders; abdomen is oval and smoothly rounded posteriorly (Plate 7E); egg sac is always attached to spinnerets and the young are carried on mother's back (Plate 7E) ..... **Lycosidae**

17. Posterior spinnerets exceptionally straight and very long, with the last segment as long as the abdomen (at least three times longer than wide) and the colulus is prominent (Plate 6F); medium to large sized spiders that are usually resting on the bark of the trees (Plate 6E) ..... **Hersiliidae**
- Posterior spinnerets not unusually long 18

18. Eyes are arranged in three groups, anterior median eyes forming a diad, well separated from other eyes arranged in two triads (Plate 4F); legs very thin and long, tarsi pseudosegmented; long-legged spiders that build loose and different dimensional webs (Plate 4E) ..... **Pholcidae**
- Eye pattern and legs not as above 19

19. Paracymbium a separate sclerite; chelicerae are often with a stridulating file (Plate 9C); tarsi are usually cylindrical, anterior tarsi sometimes fusiform (Plate 9D); small sized spiders (Plate 9B) ..... **Linyphiidae**
- Paracymbium fused to cymbium or rudimentary; tarsi variable but often tapering towards claw; chelicerae without stridulating file 20

20. Fourth tarsus with ventral comb of serrated bristles (sometimes absent, in males) (Plate 9F); brownish rings around eyes; labium not rebordered; paracymbium is a small hook at distal promargin of cymbium fused with it (Plate 10A); small to medium sized spiders (Plate 9E) ..... **Theridiidae**
- Fourth tarsus without ventral comb of serrated bristles; eyes without brownish rings; labium thickened anteriorly (rebordered); median to large sized spiders that spin orb webs and are found sitting in the centre of the snare with a closed hub (Plate 10B); males and females are similar in their shape patterns and markings, but the males have much smaller abdomens; paracymbium is often hook-shaped (Plate 10D); epigynum is sclerotized, distinct, and often with a scape (Plate 10C) ..... **Araneidae**

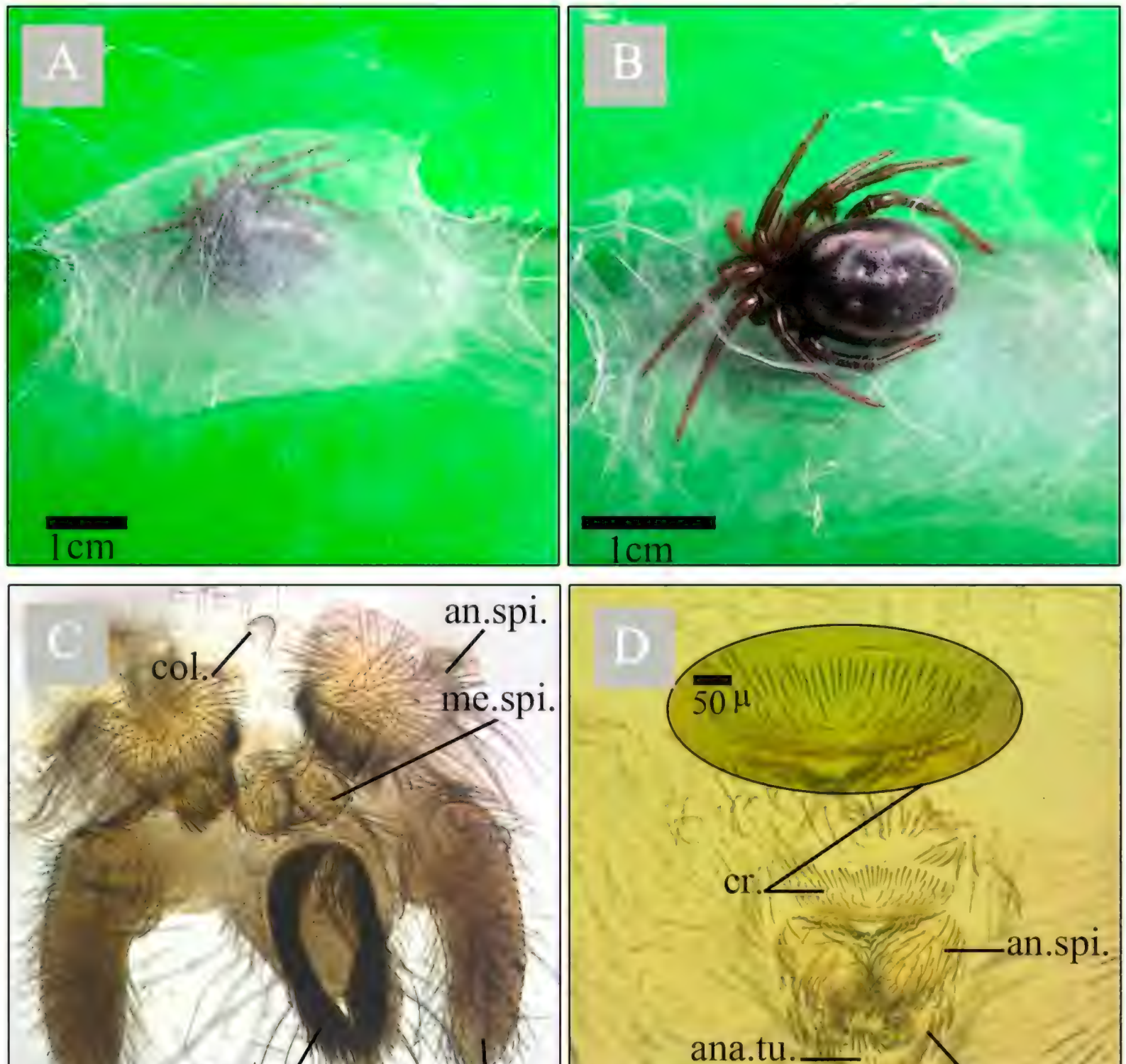

Plate 1. A-C. *Uroctea* sp., immature ♀. A-B. habitus, dorsal view, on its web. C. spinnerets and anal tubercle. D. *Dictyna* sp. ♀, spinnerets, cribellum and anal tubercle. E. *Pardosa* sp. ♀, ventral side of abdomen. F. *Filistata* sp., web and nest's entrance.

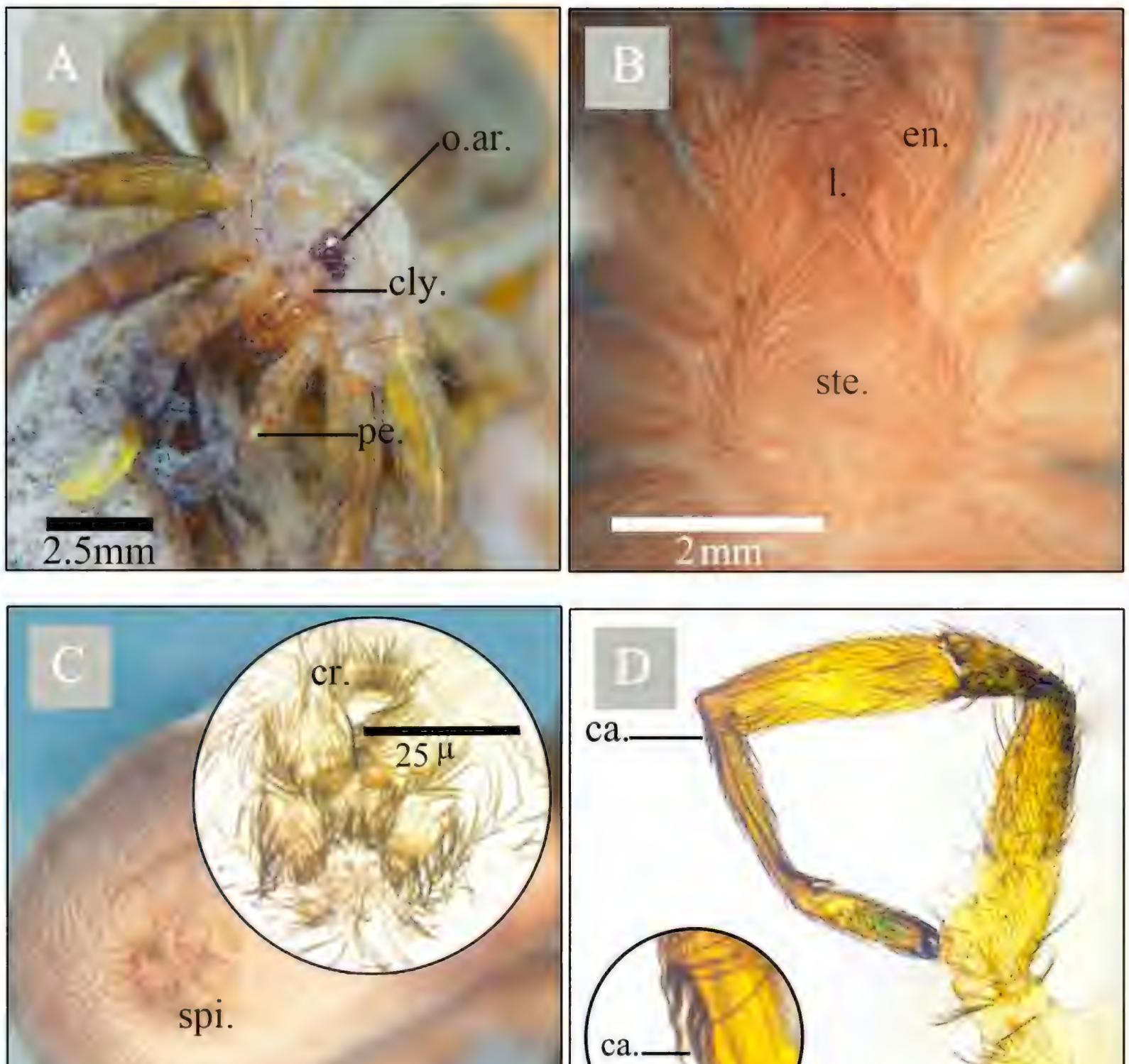

Plate 2. A-D. *Filistata* sp., immature ♀. A. on its web. B. sternum. C. venter with enlarged spinnerets. D. fourth leg with enlarged calamistrum. E-F. *Stegodyphus dufouri* ♂. E. habitus, dorsal view. F. cephalothorax, dorsal view.

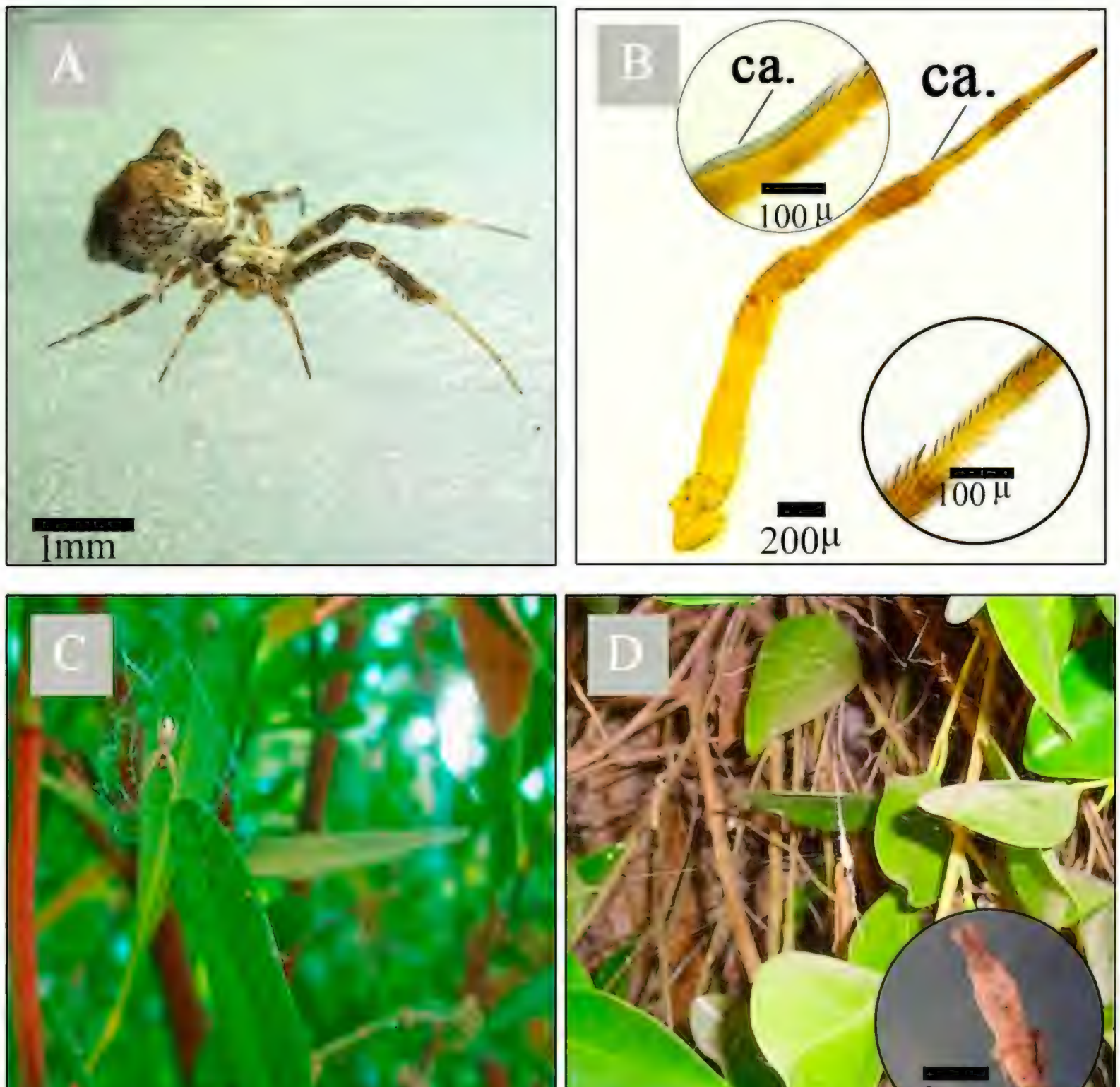

Plate 3. A-D. *Uloborus walckenaerius* ♀. A. habitus, lateral view. B. fourth leg with enlarged calamistrum. C-D. webs. E-F. *Nurscia* sp., immature ♀. E. habitus, dorsal view. F. ocular area on cephalothorax.

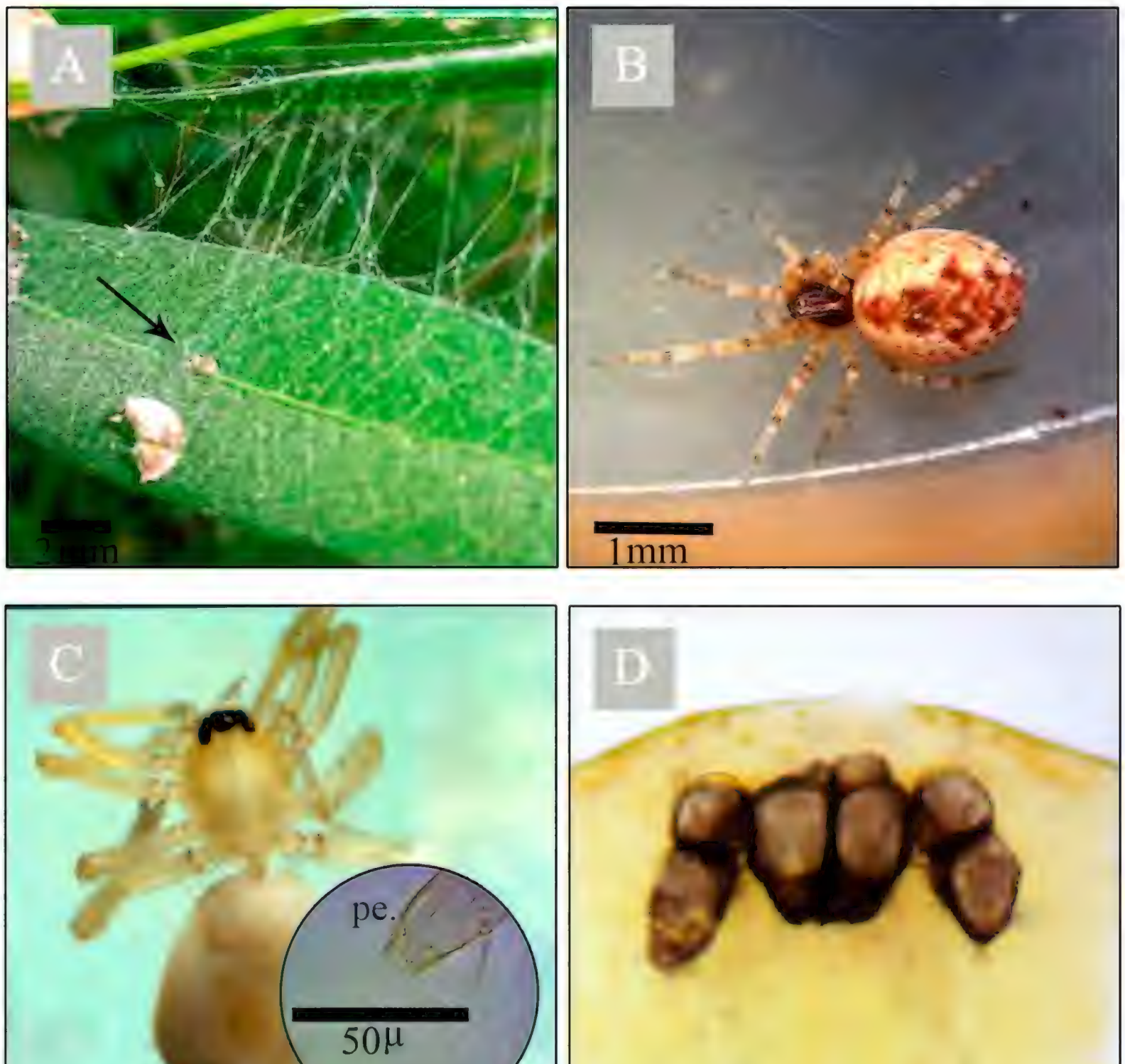

Plate 4. A-B. *Dictyna* sp. A. its web. B. habitus, dorsal view. C-D. *Orchestina* sp. ♀. C. habitus, dorsal view. D. enlarged ocular area. E-F. *Holocnemus pluchei* ♀. E. its web. F. cephalothorax, dorsal view.

Plate 5. A-C. *Thomisus spinifer* ♀. A. in its natural habitat. B. habitus, dorsal view with enlarged integument. C. first leg with enlarged portion of the tarsus and claws. D-E. *Pulchellodromus glaucinus* ♀. D. habitus, dorsal view. E. enlarged portion of the integument. F. *Thanatus albini* ♀, first leg with enlarged portion of the tarsus and claws.

Plate 6. A-B. *Poecilochroa pugnax* ♀. A. inside its retreat of curling leave. B. spinnerets and anal tubercle. C-D. *Benoitia* sp., immature ♀. C. brushed sheet web. D. spinnerets and anal tubercle. E-F. *Hersilia caudata*. E. ♀ habitus, dorsal view in its natural habitat. F. ♂ spinnerets and anal tubercle.

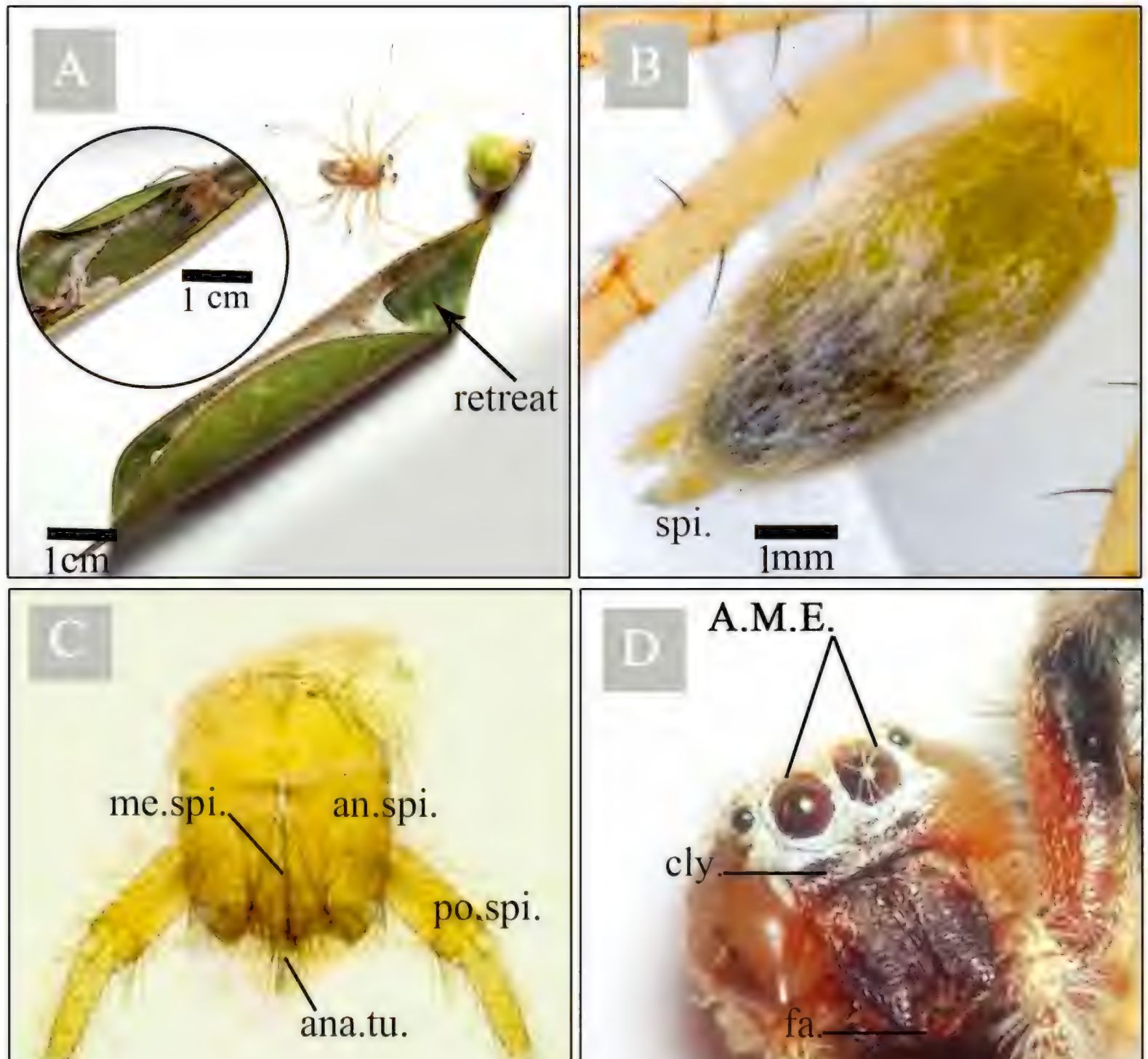

Plate 7. A-C. *Cheiracanthium isiacum* ♂. A. beside its retreat. B. abdomen, dorsal view. C. spinnerets and anal tubercle. D. *Thyene imperialis* ♂, enlarged anterior margin of the cephalothorax showing the anterior median eyes. E-F. *Pardosa* sp. ♀. E. with its cocoon. F. enlarged anterior margin of the cephalothorax showing the arrangement of eyes.

Plate 8. A-B. *Oxyopes* sp. ♀. A. habitus, dorsal view. B. enlarged anterior margin of the cephalothorax showing the arrangement of eyes. C. *Afraflacilla spiniger* ♂, enlarged cephalothorax showing the arrangement of eyes. D. *Heliophanillus fulgens* ♂, habitus, dorsal view. E-F. *Synaphris* sp. ♀. E. habitus, dorsal view. F. chelicera.

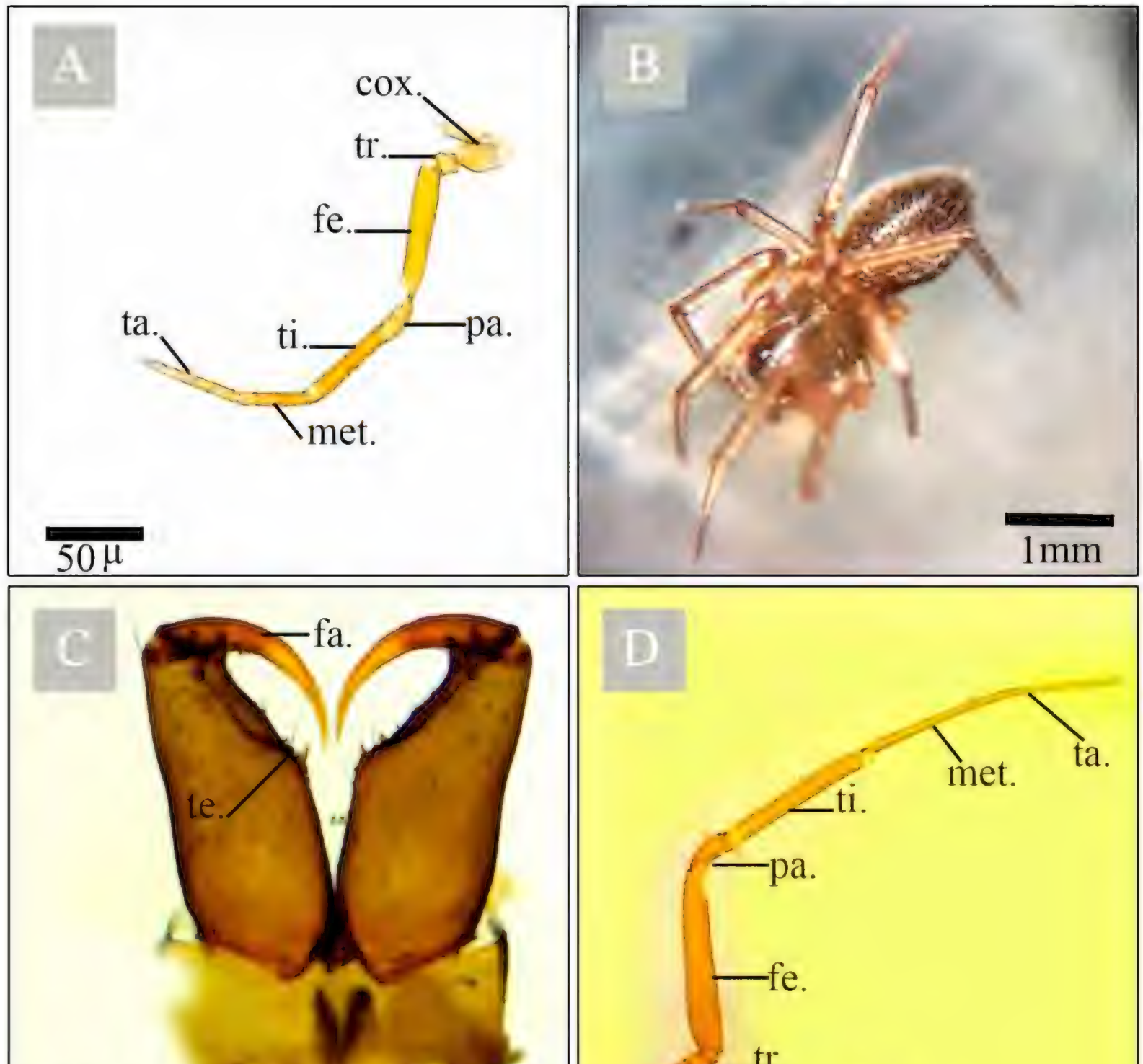

Plate 9. A. *Synaphris* sp. ♀, fourth leg. B-D. *Sengletus extricatus* ♀. B. habitus, dorsal view. C. chelicerae. D. fourth leg. E-F. *Theridion spinitarse* ♂. E. habitus, dorsal view. F. fourth leg.

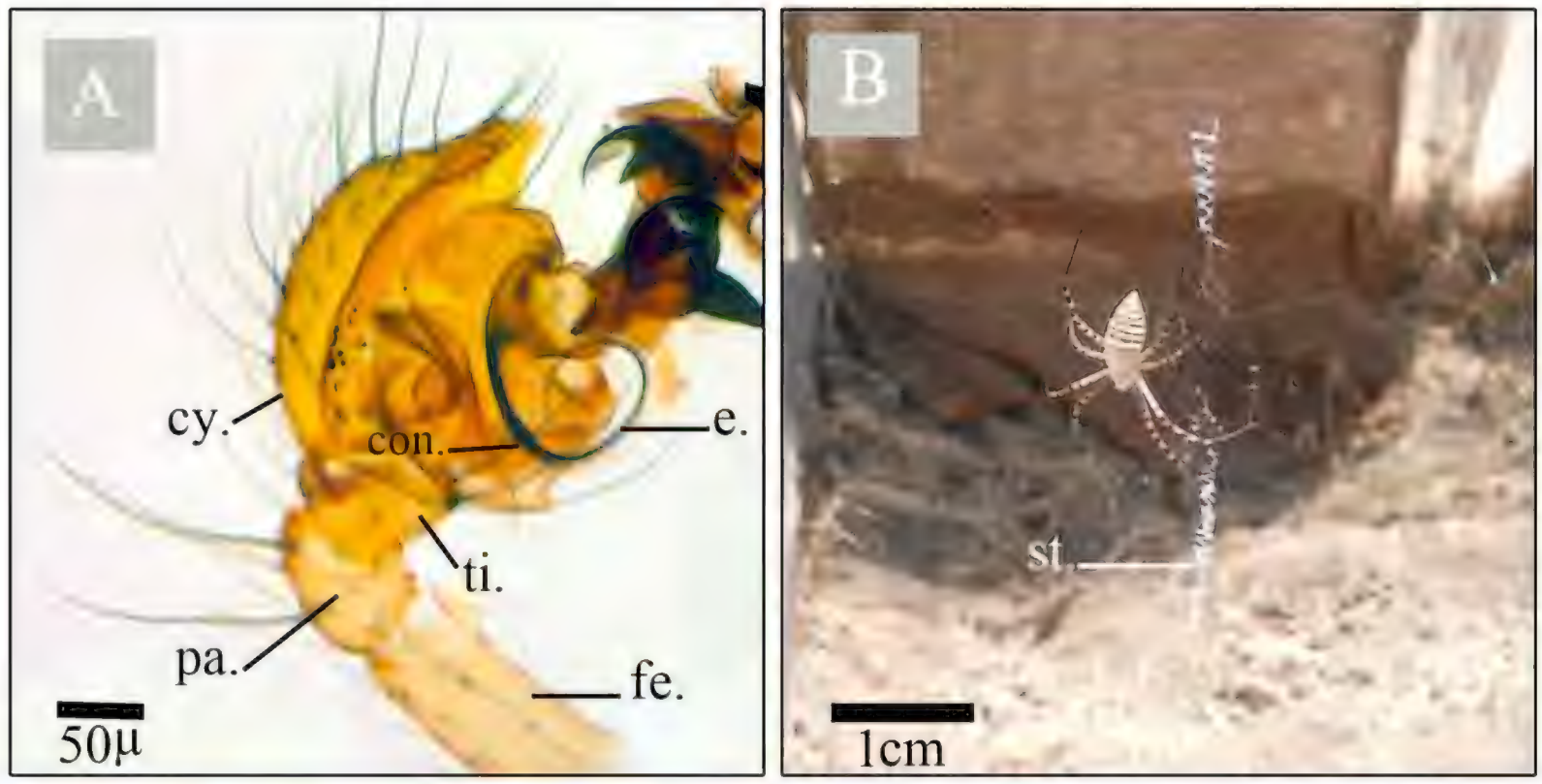

Plate 10. A. *Theridion spinitarse* ♂, lateral view of the palp. B-D. *Argiope trifasciata*. B. ♀, habitus, dorsal view, on its web in its natural habitat. C. ♀, epigynum. D. ♂ palp, dorsolateral view. E-F. *Cyrtophora citricola* ♀. E. with its cocoons on the web in its natural habitat. F. habitus, dorsal view showing the protrusions of the abdomen.

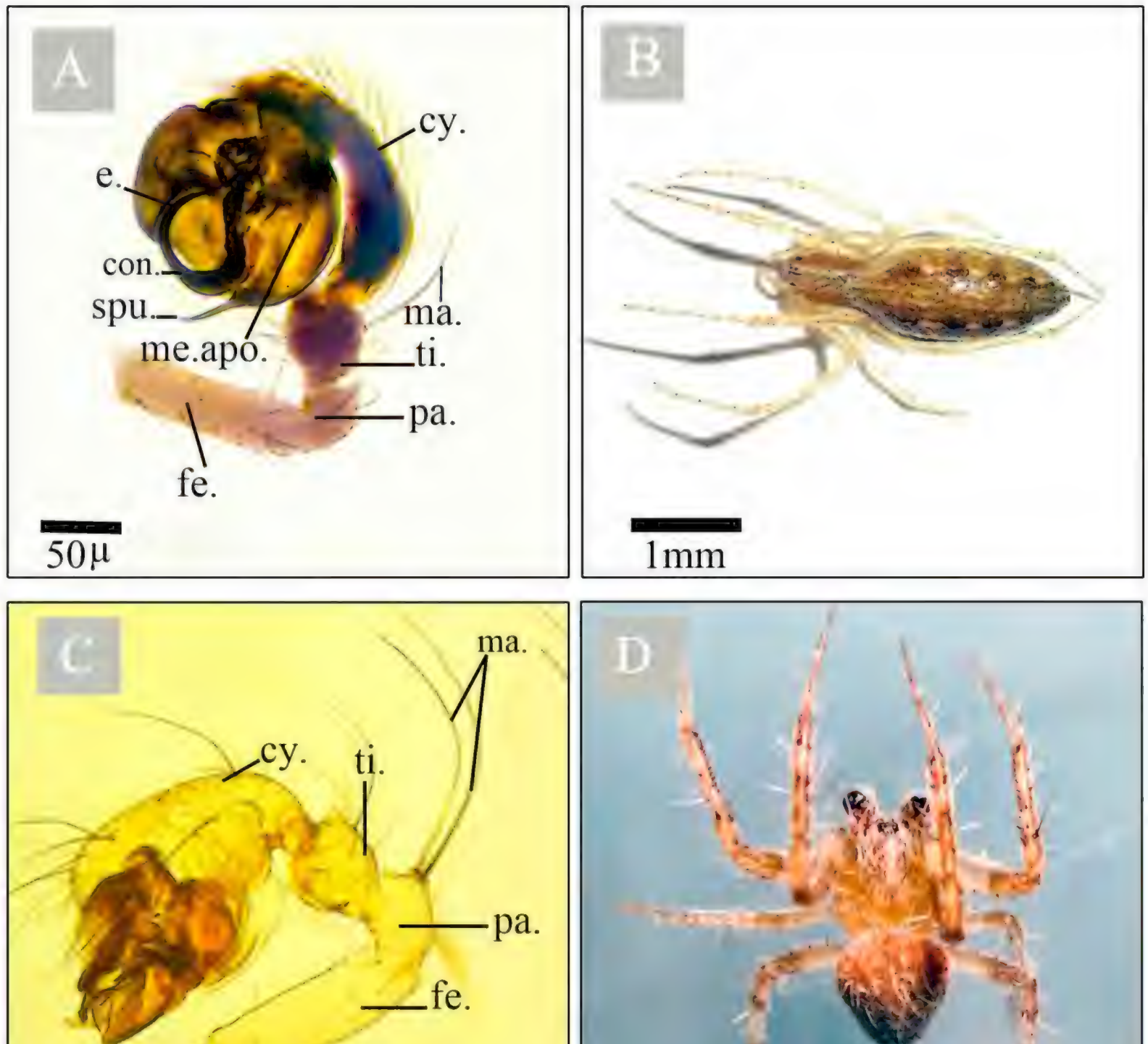

Plate 11. A. *Cyrtophora citricola* ♂, palp, lateral view. B-C. *Larinia chloris*. B. ♀, habitus, dorsal view. C. ♂, palp, lateral view. D-F. *Nesocona subfusca* ♂. D. habitus, dorsal view. E. palp, lateral view. F. second leg.

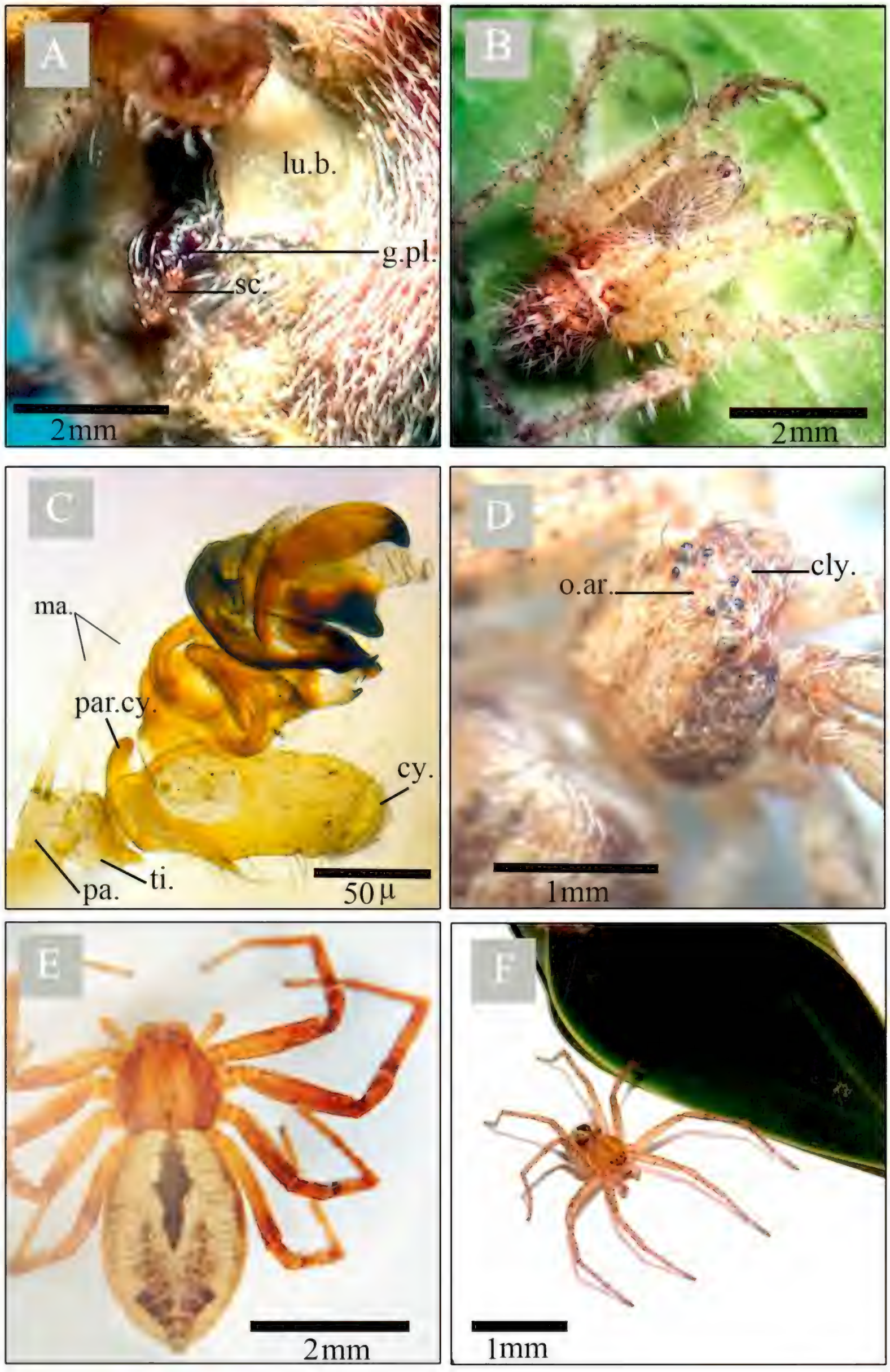

Plate 12. A. *Nesocona subfusca* ♀, genital plate, lateral view. B-C. unidentified species. B. ♀, habitus, dorsal view. C. ♂, palpal organ. D. *Pulchellodromus glaucinus* ♀, cephalothorax, laterodorsal view showing eye arrangement. F-E. *Thanatus albini*, habitus, dorsal view. E. ♀. F. ♂.

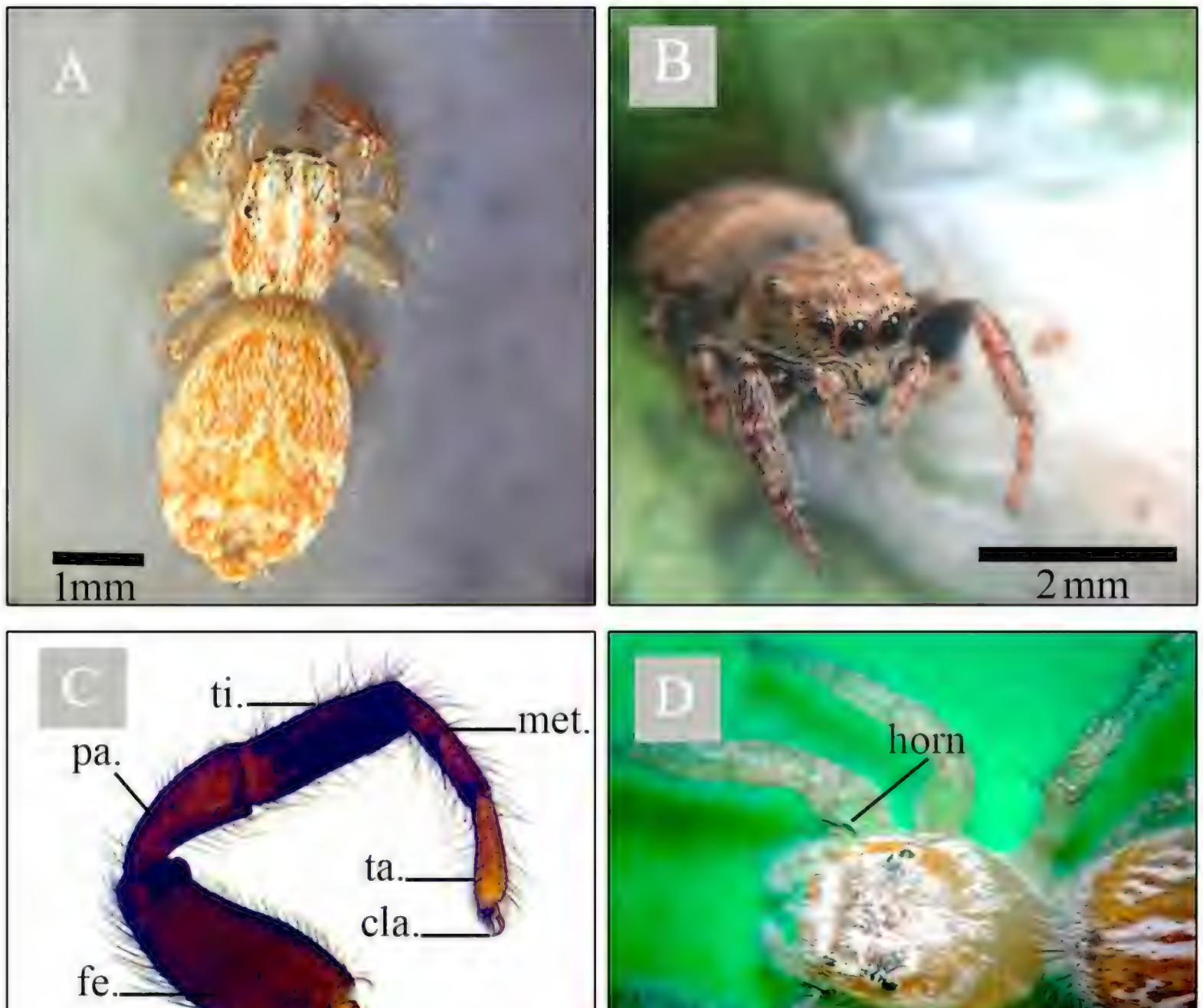

Plate 13. A. *Afraflacilla spiniger* ♀, habitus, dorsal view. B-C. *Bianor albobimaculatus* ♀. B. habitus, latero-frontal view. C. first leg. D. *Thyene imperialis* ♀, cephalothorax, dorsal view. E. *Thomisus spinifer* ♀, habitus, dorsal view. F. *Runcinia grammica* ♂, habitus, dorsal view.

Distinguishing characters of recorded species of four families:

Family Araneidae

1- Large orb-weavers, the web is usually provided with a stabilimentum (Plate 10B). Male palp with a long patellar macro-setae (Plate 10D). Abdomen of the female distinctively marked with alternate transverse black, sliver and yellow stripes (Plate 10B) ..... ***Argiope trifasciata***

2- Orb-weaver spiders. The web is more specialized having different specialized parts. Social spiders live in colony or singly (Plate 10E). Male palp with one long patellar macro-seta (Plate 10F). Abdomen with specialized dorsal tubercles (Plate 11A) ..... ***Cyrtophora citricola***

3- Abdomen is thin and elongate with a prominent anterior protrusion hanging the cephalothorax and a pointed posterior end (Plate 11B). Male palp with two long patellar macro-setae (Plate 11C) ..... ***Larinia chloris***

4- Abdomen is large and triangular (Plate 11D). Male palp with two long patellar macro-setae (Plate 11E). Tibiae of the second legs is long with two rows of strong short spines (Plate 11F). Genital plate with a tongue like scape (Plate 12A) ..... ***Nesocona subfusca***

Family Philodromidae

1- The distance between eyes in the anterior and posterior eye rows are unequal (Plate 12D) ..... ***Pulchellodromus glaucinus***

2- The distance between the eyes in the anterior and posterior eye rows are equal (Plates 12E, 12F) ..... ***Thanatus albini***

Family Salticidae

1- General appearance of the body is long and relatively flat (Plate 13A) ..... ***Afraflacilla spiniger***

2- The carapace and the abdomen have brown to black colour without distinct pattern (Plate 13B). Femora and tibiae of the first pair of legs are greatly enlarged (Plate 13C) ..... ***Bianor albobimaculatus***

3- The carapace and the abdomen have black colour, often with a metallic sheen. Abdomen often with thin white bands of white hairs. The pedipalps and the legs are pale yellow (Plate 8D) ..... ***Heliophanillus fulgens***

4- Cephalothorax is recognized by its swelling. There are two horns of long black setae, one on each lateral side of the ocular area (Plate 13D) ..... ***Thyene imperialis***

Family Thomisidae

1- The ocular area is thickened and elevated with laterally projected large horn like tubercles. The abdomen is pentagonal to triangular in shape, being widened and truncated behind (Plates 5A, 5B, 13E) ..... ***Thomisus spinifer***

2- The carapace is semi-circular and the abdomen is elongated (Plate 13F) ..... ***Runcinia grammica***

Discussion

This paper highlights the biodiversity of the spiders in lemon trees, olive trees, and *Cyrtophora citricola* webs. It is the first of its kind at Sohag Governorate.

Covering the diversity of Egyptian spiders is still incomplete because of the little and sporadic works in this field. El-Hennawy (2017a) listed 405 spider species belonging to 204 genera and 41 families from different regions of Egypt. In the present work, 30 spider species belonging to 29 genera and 21 families are listed.

This study coincides with the hypothesis of Robinson (1981), Rypstra (1983), and Ziesche & Roth (2008) about the differences in the diversity and abundance of spiders. These differences may be due to their geographical distribution and climatic conditions which cause variation in vegetation types. Moreover, they may be affected by natural enemies, abundance of prey, types of collection methods and human impacts (Wise, 1993; Henderson, 2007).

By comparing the spider families in the present study with other studied areas in Upper Egypt that are slightly apart from our study area (i.e. Assiut and Qena Governorates) (Table 3). Obuid-Allah *et al.* (2017) collected spiders at random manner from six different sites at Assiut Governorate, using only hand picking method. Taxa collected were assigned in 42 genera and 47 species that fall in 22 families. All of the recorded families were recorded in the present study except the four families: Dysderidae, Liocranidae, Sicariidae, and Sparassidae. Also, Obuid-Allah *et al.* (2017)'s survey did not report the families: Oonopidae, Oxyopidae, and Synaphridae that were recorded in the present study.

In Qena Governorate, Obuid-Allah *et al.* (2015 a, b) and Obuid-Allah *et al.* (2018) collected terrestrial spiders from six different sites using three sampling methods: hand picking, sweeping nets, and pitfall traps. They revealed the presence of 23 species that are belonging to 23 genera and 14 families. All these families are recorded in the present study except family Sparassidae. However, they did not record the eight families: Dictynidae, Eresidae, Filistatidae, Hersiliidae, Oonopidae, Synaphridae, Titanoecidae, and Uloboridae.

In Sohag Governorate, Mohafez (2000) collected spiders at random manner from different vegetable crops, field crops and from different orchards distributed in seven regions at Sohag Governorate using two methods of collection: branch shaking, and hand picking. This work revealed the presence of 19 families comprising 29 spider species. However, Mohafez *et al.* (2010) collected spiders randomly from different orchards (olive, citrus, grapes, guava, and mango) in two other localities at Sohag Governorate using branch shaking, silky traps, and bit-fall traps. They revealed the presence of 17 families comprising 22 genera and 25 spider species (Table 3). In addition to these works, family Eresidae, represented by *Stegodyphus dufouri*, was previously recorded by El-Hennawy (1990) from Sohag.

Regarding to the present work and the available works on Sohag Governorate, all of the recorded families were recorded except the three families: Corinnidae, Dysderidae, and Sparassidae. Moreover, the present study added two families: Synaphridae, and Oxyopidae, 18 genera (including 8 unidentified species), and 11 species. Ten of the recorded species: *Argiope trifasciata*, *Larinia chloris*, *Neoscona subfusca*, *Poecilochroa pugnax*, *Sengletus extricatus, Holocnemus pluchei*, *Afraflacilla spiniger*, *Bianor albobimaculatus*, *Heliophanillus fulgens*, and *Theridion spinitarse* are considered new locality records.

In this investigation, the most dominant families in olive trees were Salticidae followed by the abundant family Cheiracanthiidae. Araneidae was frequently abundant and Lycosidae was considered rare. Whereas, Mohafez *et al.* (2010) pointed out that the dominant families were Lycosidae, Salticidae, and Araneidae. On the other hand, the dominant family in Citrus orchards was Theridiidae followed by the abundant family, Cheiracanthiidae. However, the frequently abundant families: Linyphiidae and Salticidae were considered rare. Mohafez *et al.* (2010) reported that the dominant families were Lycosidae, Theridiidae, and Linyphiidae.

Table 3. Comparison between habitats, methods of collecting and the recorded families of the previously reported researches in Upper Egyptian Governorates.

Governorate	**Qena**	**Sohag**		**Assiut**
Sites	Six sites cover all parts of Qena Governorate	Seven sites: Akhmim, El-Baliana, El-Maragha, El-Menshah, Gerga, Johyna, and Sohag	Two sites: Tahta and Temma	Six sites covering Assiut Governorate
Habitat	Terrestrial and vegetation habitat	Different vegetable crops (tomato, potato and pepper), field crops (corn and broad bean) and from different orchards (mango, citrus, fig, guava, and grapes)	Different orchards (olive, citrus, grapes, guava and mango)	Different habitats
Collecting methods used	Hand picking, sweep net, and pitfall traps methods	Two methods of collecting; the first is the branch shaking over reversed umbrella for arboreal spiders, while the second is hand collecting for ground spiders	Different methods included umbrella (branch shaking), screening (silky trap), and pitfall traps	Only hand picking method
Recorded families	Agelenidae, Araneidae, Eutichuridae *, Gnaphosidae, Linyphiidae, Lycosidae, Oecobiidae, Oxyopidae, Philodromidae, Pholcidae, Salticidae, Sparassidae, Theridiidae, Thomisidae.	Agelenidae, Araneidae, Dictynidae, Filistatidae, Gnaphosidae, Hersiliidae, Linyphiidae, Lycosidae, Miturgidae *, Oecobiidae, Oonopidae, Philodromidae, Pholcidae, Pisauridae, Salticidae, Sparassidae, Theridiidae, Thomisidae, Uloboridae.	Araneidae, Corinnidae, Dictynidae, Dysderidae, Gnaphosidae, Hersiliidae, Linyphiidae, Lycosidae, Miturgidae *, Oecobiidae, Philodromidae, Pholcidae, Pisauridae, Salticidae, Theridiidae, Thomisidae, Uloboridae	Agelenidae, Araneidae, Dictynidae, Dysderidae, Eresidae, Eutichuridae *, Filistatidae, Gnaphosidae, Linyphiidae, Liocranidae, Lycosidae, Oecobiidae, Philodromidae, Pholcidae, Pisauridae, Salticidae, Sicariidae, Sparassidae, Theridiidae, Thomisidae, Titanoecidae, Uloboridae
References	Obuid-Allah *et al.*, 2015 a, b and Obuid-Allah *et al.*, 2018	Mohafez, 2000	Mohafez *et al.*, 2010	Obuid-Allah *et al.*, 2017

* Now, genus *Cheiracanthium* is in family Cheiracanthiidae.

Conclusion

The present study provides new information on the distribution, abundance and taxonomy of the different families, genera and species of spiders in three different habitats: olive trees orchard, lemon trees orchard, and *Cyrtophora citricola* webs. Moreover, taxonomic keys for the recorded families and species that can be used in future taxonomic work are constructed. Also, further studies are recommended to identify new species in Sohag Governorate by exploring new habitats and using new methods for collecting.

Acknowledgments

We are grateful to the Research Group at the Agricultural Research Center in Jazirat Shandweel District, Sohag Governorate, especially Prof. Mahmoud Ahmed Helmy and Dr. Hossam El-Gebaly, for their kind help during spiders collecting. Dr. Mostafa Redwan, Assistant Prof. in Geology Department, for his kind help. Also, we would like to express our sincere thanks to Mr. Hisham K. El-Hennawy, the Arachnology Expert of Egypt, Cairo, for his help in confirming the identification of different collected spiders.

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